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SYMPOSIUM ON

Emergencies in Dental Practice

JAMES R. CAMERON, D.D.S.

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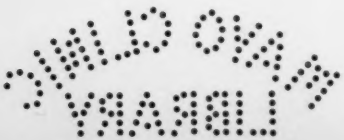

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Contents

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Foreword

The trend in dental education is to widen the scope of practice, and this trend is placing on the dentist an increasing responsibility to meet the broader concepts. Modern texts and current periodical literature bring to him new information on therapy and techniques in such volume that systematic reading is imperative for the dentist who wishes to keep abreast of the many advances that are taking place in dentistry and allied fields.

This issue of *Dental Clinics of North America* is devoted to the management—and the prevention—of emergencies in the practice of general dentistry and oral surgery. It contains valuable instruction relative to the many problems that may face both the general dental practitioner and the dental specialist. The contributors have been carefully selected in order that readers may obtain the value of their combined knowledge and experience.

Emergencies frequently arise in the offices of general dentists and specialists alike, and it is the responsibility of the dentist to know what to do immediately. The neighborhood dentist, and the dentist practicing in an area remote from a large city, are often called upon to provide emergency care for persons who have been injured on the streets or highways or as a result of accidents occurring in the home or in an industrial plant. In addition, should a major catastrophe occur as a result of enemy action, dentists, by virtue of their basic medical knowledge and training, will share with physicians the duty of caring for those who survive such an attack.

It is hoped that the material presented here will serve as a ready source of authoritative information on the handling of the many kinds of emergencies that the dentist must be prepared to face.

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Anesthetic Emergencies in the Dental Office

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Many of the emergencies occurring in the dental office are associated with anesthetic procedures, either regional or general. An emergency may be defined as an unforeseen combination of circumstances requiring immediate attention. It should be stressed that all emergencies are not necessarily life-endangering, but the element of doubt as to the final outcome is ever-present. Therefore, emergency treatment is always indicated.

Emergencies in the dental office are not common; however, they are also not rare. Any dentist may at any time find himself precipitated into an emergency situation, as the use of the anesthetic agents is not always the benign procedure that many believe it to be.

Every dentist should understand thoroughly the causes, earliest symptoms, and treatment of all reactions to the various anesthetics that he might employ, as the urgency of most emergencies does not permit a perusal of the literature or a leisurely discussion of the problem.

It is especially important that every dental office should be equipped to treat the anesthetic emergencies most likely to occur, as it would be impossible to secure quickly enough the necessary drugs and material that are not readily available at the time of the occurrence.

EMERGENCIES ASSOCIATED WITH USE OF LOCAL ANESTHETICS

The local anesthetic drugs are the most commonly used systemic drugs in dentistry. Every dentist should, therefore, be well versed in the handling of emergencies associated with these drugs as every

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local anesthetic in use today is capable of producing adverse reactions, many of which will be emergency in nature.

The emergencies most likely to occur during or following the use of the local anesthetics are fainting, those associated with needle breakage, toxic overdose, idiosyncrasy, and allergy.

Fainting

Fainting is the most common emergency in the dental office and is often associated with the use of local anesthesia; but it should never be attributed to the effects of the local anesthetic solution itself. It is more often brought about by psychic factors or by the trauma of the needle insertion.

No other clinical symptom is as common or well known to both the practitioner and the layman as fainting. Practically every dentist has at sometime or other had a patient faint during or following the needle insertion. However, despite the ubiquity of fainting, the knowledge of it remains superficial.

While the sudden loss of consciousness represents the most dramatic symptom of fainting or syncope, this is by no means the only or earliest manifestation. In the vast majority of cases, the patient will first complain of feeling "faint," a condition characterized by pallor, light-headedness, dizziness, and in some instances, nausea. Often the patient may not experience a complete loss of consciousness.

When these symptoms are presented, an emergency exists in that something must be done to alleviate the patient's condition. The complete loss of consciousness will most likely be avoided if the patient's head is lowered below the level of his body.

Loss of consciousness, whether for reasons psychic or otherwise, is due to some disturbance in the mechanism for maintaining normal blood pressures. The vascular bed dilates, creating a discrepancy between the circulating blood volume and the vascular bed that results in a lowered blood pressure. The brain, because of its superior position, feels the effects of the transient anemia and subsequent hypoxia with the loss of normal function.

Treatment. The patient should be placed in a supine position in the chair with the head as low as possible. This position is preferable to bending the patient forward, as abdominal compression in the unconscious patient could interfere with normal respiration and even with circulation. Oxygen, which should be available in every dental office, should be administered. In cases of true syncope the hasty use of analeptics, stimulants and other drugs should be avoided unless specifically indicated.

Prevention. Fainting in most instances can be prevented if the dentist considers the patient's mental attitude and his susceptibility to psychic trauma. It is advisable to gain the patient's confidence by psychotherapy, which should be practiced automatically by every practitioner. The patient should be informed just what to expect, as many patients react poorly to unpleasant surprises. Needles and syringes should be kept out of view. The extremely apprehensive patient should receive the benefits of premedication, when indicated.

Needle Breakage

When a needle breaks during its insertion a true emergency exists in that some immediate action is necessary to prevent the situation from becoming much more serious. Very few emergencies can be treated as successfully with less harmful results if the condition is immediately recognized and efficiently handled. The patient should not be alarmed, for if he becomes excited he may close his mouth and initiate muscular movements which may cause the needle to be drawn out of sight into the tissues.

A suitable instrument for grasping the needle should be readily available at all times. The needle will usually break at the hub and, if properly inserted, will leave a sufficient length protruding from the tissues to be grasped and withdrawn.

Prevention. Observance of these rules will prevent needle breakage:

1. Do not attempt to change the direction of the needle while it is embedded in the tissue.
2. Do not insert the needle rapidly.
3. Do not insert the needle without first warning the patient as to what to expect.
4. Do not attempt to overcome resistance, or force the needle into bone.
5. Do not use the same needle over and over again until it becomes dangerously weak.
6. Do not use too fine a needle for deep injections.
7. Do not completely bury the needle in tissues. One-third to one-half the length of the needle should protrude from the tissues.

Toxic Overdose

The most common emergency which can be attributed to the local anesthetic solution itself is that of toxic overdose. This emergency will occur whenever a sufficient amount of the drug involved is absorbed

into the blood stream to adversely affect the higher centers of the central nervous system.

The local anesthetic solution will usually consist of the anesthetic agent, the vasoconstrictor, a preservative and the vehicle. Of these ingredients, the anesthetic agent and the vasoconstrictor are capable of producing toxic reactions.

All of the local anesthetics are capable of causing toxic reactions, particularly if the drug is inadvertently injected intravenously. The possibility of a toxic reaction depends upon the rate of absorption into the systemic circulation, as compared with the speed of breakdown and elimination. When the absorption into the blood stream is more rapid than the hydrolysis, detoxification and elimination, a blood level will eventually be reached which will adversely affect those centers most susceptible to the drug.

The vast majority of toxic reactions to local anesthetics are caused by the inadvertent intravascular injection of the anesthetic solution. The volume and the percentage strength of the local anesthetics as used in dentistry are well within the limits of safety and it is doubtful if this amount, particularly since it contains a vasoconstrictor, could be absorbed into the circulation rapidly enough to cause a systemic reaction unless it were deposited in whole or in part directly into the blood stream. In these cases of intravascular injection, a volume and concentration usually in excess of that needed to adversely affect the vital centers is immediately placed in the circulating blood.

If during the administration of a local anesthetic, an immediate reaction occurs, it is certain that the drug has been administered intravenously, as it is unlikely that an amount sufficient to create a reaction could be absorbed from the tissues into the blood stream in so short a period of time. As a rule, any reaction due to toxic overdose will occur within 20 to 30 minutes of the time of injection, or there will be no reaction at all.

Symptoms. The very earliest symptoms of a toxic reaction will be those of central nervous system stimulation, as the local anesthetic drugs, with the exception of Xylocaine, first stimulate the higher centers of the central nervous system, and secondarily depress them in direct proportion to the degree of stimulation. The greater the stimulation, the greater the depression, with the patients who have demonstrated convulsive seizures usually developing severe respiratory and cardiac depression.

The very earliest symptoms of toxicity to local anesthetic drugs, with the possible exception of Xylocaine, will be (1) mild excitement, (2) talkativeness, (3) anxiety, and (4) possibly nausea and vomiting.

If the above symptoms occur during or immediately following the

injection of a local anesthetic, it is unwise to attribute them to nervousness or apprehension. Fortunately, the vast majority of toxic reactions are of a mild stimulating type with only a minor degree of depression. However, in some instances, especially if the drug is inadvertently administered intravenously, the mild stimulating phase may pass very rapidly, terminating in convulsions followed by severe central nervous system depression. On rare occasions the local anesthetic, particularly if administered intravenously, may result in a sudden cardiovascular collapse.

Treatment. In the majority of local anesthetic reactions of the toxic type, particularly when they are mild in nature, no specific treatment other than discontinuing the administration of the drug will be necessary. However, if the full dosage has been administered and the stimulating phase is continuing or progressing, intravenous barbiturates, most likely Nembutal or Seconal, should be given in sufficient quantity to control the stimulation. Oxygen should then be administered. In many cases oxygen alone may be the only treatment necessary, particularly if the stimulation is not too severe. In cases of convulsions sufficient barbiturates should be given intravenously to control the convulsive seizures, while oxygen is administered to maintain the adequate oxygenation of the patient.

When the toxic emergency has occurred suddenly and passed through the stimulating phase with extreme rapidity, resulting in severe depression, it will be necessary to maintain the oxygenation of the patient with controlled respiration while at the same time measures are taken to support the circulation.

In severe cases of extreme central nervous system depression or cardiovascular collapse, the dentist should be expected to institute the immediate emergency treatment until other professional help can be summoned. It should not be considered a demonstration of the dentist's shortcomings or inadequacies to seek other more qualified professional help. It is, on the contrary, sound judgment to seek consultation and help when a severe emergency, such as described, occurs. It should be stressed that on many occasions, even though help is summoned, the initial treatment as instituted by the attending dentist may decide the final outcome.

Prevention. The signs and symptoms of toxic overdose, while usually easy to recognize and treat, may on occasion occur with such rapidity and suddenness that it may be all but impossible to treat them successfully. This tends to emphasize the necessity for prevention rather than treatment.

To prevent toxic reactions successfully certain fundamental principles should be followed:

1. The patient should be adequately evaluated before administration of a regional anesthetic.
2. A vasoconstrictor should be employed with local anesthetics.
3. The least possible volume should be used.
4. The weakest concentration compatible with successful anesthesia or analgesia should be employed.
5. The injection should be made slowly.
6. Always aspirate before injecting.
7. Premedicate with a barbiturate when larger volumes are to be injected.
8. Select the anesthetic drug with care and caution.

Toxicity from the Vasoconstrictor. The vasopressor drugs—epinephrine, Cobefrin, Levophed, and Neo-Synephrine—which are an integral part of practically all local anesthetic solutions, may in themselves produce toxic effects. The same rules for absorption, breakdown and elimination hold for these drugs as for the local anesthetics. These drugs occupy a unique position, in that very few drugs, particularly in the dosages used in dentistry, are so safe when administered in the tissues and yet so dangerous when inadvertently administered intravenously.

Symptoms. The symptoms of the toxic effects of the vasoconstrictors are (1) tachycardia, (2) palpitations, (3) headache, and (4) an awareness that all is not well.

When the above symptoms occur, it can be almost certain that the reaction is due to the vasoconstrictor and not to the anesthetic agent. Rarely, if ever, will vasoconstrictors cause convulsions or grossly alter respirations.

Treatment. Reactions to the vasoconstrictors are fortunately of short duration. However, when they do persist the patient should be given oxygen as well as small doses of intravenous barbiturates. The pulse should be taken at intervals to ascertain the presence of any arrythmias. No attempt should be made to treat any noticeable arrythmia, but medical advice should be sought while the previously outlined treatment is followed.

Prevention. Emergencies due to the administration of a vasoconstrictor are more easily prevented than treated.

1. Aspirate before injecting so that what may be a harmless concentration of the vasoconstrictor is not injected intravenously with harmful sequelae.
2. Do not use vasoconstrictors when they are specifically contraindicated, as in cases of thyrotoxicosis.
3. Markedly reduce the vasoconstrictor concentration used in patients with certain cardiovascular diseases. It is suggested that not more than 0.02 to 0.04 mg. be used. This would mean that not more

than 4 cc. of a solution of 1:100,000 concentration should be used in such patients at any one sitting.

4. The volume and concentration should be closely noted so that even in apparently normal healthy patients the total vasoconstrictor dosage does not exceed 0.2 mg. of epinephrine. Neo-Synephrine, Cobefrin and Levophed should be used in the comparative amounts as indicated.

Idiosyncrasy

Idiosyncrasy may be defined as a hypersensitivity to a drug which results in bizarre reactions when a comparatively small amount of the drug has been used.

It is most difficult to classify such a reaction because the variety of symptoms may be odd and unrelated. The individuals concerned exhibit symptoms which seem to be in no way related to the pharmacology of the drug. When the symptoms manifested cannot be classified as due to toxic overdose or allergy, it is most reasonable that these patients be noted as having an idiosyncrasy toward the particular drug.

The degree of a patient's idiosyncrasy may vary from day to day in the same individual. The dentist should closely observe all patients following the injection of a local anesthetic so that he may diagnose accurately any untoward reaction requiring emergency treatment. In the cases of idiosyncrasy it will be necessary to treat these symptoms as they occur.

Prevention. Such emergencies may best be prevented by:

1. Taking an adequate history so as to discover such tendencies.
2. Using drugs to which the patients have not had previous reactions.
3. Adequately premedicating patients so that psychic factors may be eliminated.
4. Avoiding appointments for these particular patients on extremely hot days, as these types of reactions seem more prevalent at this time.

Allergy

Allergy may be defined as a specific hypersensitivity to a drug, or to any drug of the same chemical derivation. While a great deal has been written concerning allergic reactions to local anesthetic drugs, such reactions are comparatively uncommon. It has been estimated that about 1 per cent of all reactions occurring during local anesthesia are allergic in their origin.

Allergy is an antigen-antibody type of reaction and may be acquired or familial. The acquired type of allergy, as far as local anesthesia is concerned, embraces most forms of hypersensitivity including anaphylactoid reactions. The skin, mucous membrane, and blood vessels are the shock organs, and an allergic reaction is manifested by urticaria, wheals, edema and migraine.

In order that a patient may exhibit an allergic response he must have had the drug in question, or one of similar chemical derivation, administered sometime previously. In other words, the patient must have had a sensitizing dose.

Signs and Symptoms. The signs and symptoms of an allergic reaction may be mild or severe, immediate or secondary. The immediate reactions will be the more severe, and a patient who has previously been sensitized may react violently and suddenly to only a very small amount of the drug. In some cases a test dose itself may be harmful. Delayed reactions are as a rule more annoying than serious and are usually manifested by local edema in the area of injection. This may occur from 12 to 24 hours after the original injection. Secondary allergic manifestations are often a forerunner of more serious immediate reactions, if the same drug is used at a subsequent appointment.

Anaphylactoid reactions are a form of allergic manifestation. In these cases a sudden violent loss of vasomotor tonus is exhibited, resulting in the absence of a pulse or blood pressure. Respiration may rapidly become inadequate and death is not unusual. This is without a doubt the most terrifying and distressing reaction to local anesthetics. Fortunately it is rare.

If a fatality is to be avoided in this type of reaction, it will be the result of prompt and accurate treatment. Even then, success may not be forthcoming.

Treatment. The treatment of an allergic response must follow the type of reaction exhibited. If the reaction is an extremely mild one no treatment may be necessary, but it should definitely be noted that the patient has had such a reaction and the drug should not be repeated at a future time, as the reaction then may be extremely severe.

If the symptoms are a mild rash, urticaria or edema of the angioneurotic type, an antihistaminic drug can be administered. However, in mild cases in which immediate treatment is not necessary it would be wise to consult an allergist or any physician before prescribing any medication.

Benadryl (diphenhydramine) in 20 mg. doses could be administered intravenously or orally at the time of the original allergic reaction. Any future administration, if necessary, should be prescribed by the patient's physician.

Adrenalin (epinephrine) 1:1000 may be administered intramuscularly in doses of 3 to 5 mg. The same rule—subsequent treatment by a physician—should also follow the epinephrine administration.

More severe cases involving the tracheobronchial tree should be treated by the administration of oxygen under pressure plus Benadryl intravenously in 50 mg. doses, or aminophylline intravenously (7½ grs.). Here also further help should be obtained for more efficient handling of the case.

Prevention. Allergic emergencies may best be prevented by:

1. Taking a good history to determine any previous allergies.
2. Not using any drug to which the patient has given a previous history of allergy.
3. Carefully questioning and seeking professional advice on the treatment of patients who have asthma or fungus infections.
4. Not attempting a skin test to determine the patient's allergic status to any given drug. This should be done by an allergist or one trained in the particular field.
5. Injecting very slowly and noting any allergic response which may be exhibited.

EMERGENCIES ASSOCIATED WITH USE OF GENERAL ANESTHETICS

A much greater percentage of the complications occurring during general anesthesia are emergency in nature, in that they require some immediate treatment. During general anesthesia a seemingly minor complication may, from neglect, become a serious emergency.

Emergencies may affect one or more of the following systems: respiratory, cardiovascular, nervous, and gastro-intestinal.

The vast majority of emergencies occurring during anesthesia for oral surgery are primarily respiratory in nature and induce a degree of hypoxia or, if severe enough, anoxia. This oxygen lack may further create emergencies involving the circulatory, nervous, or gastro-intestinal systems. On the other hand, vomiting during anesthesia, a gastro-intestinal emergency, may grossly interfere with respiration and create a respiratory emergency, with the subsequent hypoxia causing cardiovascular and nervous system emergencies.

Respiratory Emergencies

Any interference with the exchange of gases (oxygen and carbon dioxide) between the external atmosphere or anesthetic machine and the body cells constitutes an emergency which, if not corrected, may over a short period of time lead to dire consequences. The most com-

mon respiratory emergencies are (1) obstruction, mechanical or physiologic, (2) low oxygen percentage or partial pressures in the inspired gases, and (3) inefficient carbon dioxide elimination.

Mechanical Respiratory Obstruction. The most common emergency in anesthesia, particularly for oral surgery, is mechanical respiratory obstruction. This may come about in many ways and is a problem particularly because the anesthetist and the oral surgeon are literally at work in the same area. Also, in many cases, manipulation by the operator sometimes tends to overcome the efforts of the anesthetist to support the head and chin in proper position to maintain a patent airway.

Blood, mucus or debris, if allowed to accumulate in the retropharynx, may create a serious respiratory obstruction. A seemingly insignificant interference with the normal respiratory exchange may reduce the inspired volume by as much as 50 per cent. This at first may seem harmless but as the oxygen deficiency increases, circulatory, nervous, and gastro-intestinal system emergencies may be initiated.

The earliest symptoms of a mechanical respiratory obstruction will be a definite change in the respiratory pattern with a decreased volume of inspiration and expiration. The anesthetist should be readily able to note this decrease in respiratory volume and labored efforts of the patient. The smooth unimpeded expansion of the thoracic cage will be absent while the abdominal muscles will spastically contract with effort. Hypoxia will very soon be in evidence, with an increase in pulse rate and, in some cases, early cyanosis.

If the obstruction cannot be overcome within a reasonable time (30 to 45 seconds) all oral surgical procedures should be halted so that the efforts of the surgical team—surgeon, anesthetist and nurse—may be concentrated on restoring normal respiration. The surgeon should release all pressure upon the mandible, remove any partitions in place and draw the tongue forward. The nurse or assistant should then carefully suction the retropharynx to remove any blood, mucus or debris. The anesthetist can then properly position the head and chin while augmenting the inspiratory phase with controlled respiration. When the retropharynx is clear and free of all debris and respiration is adequate and unobstructed, the surgeon may draw the tongue forward and carefully replace the partition and continue with the surgery.

Oftentimes minor adjustments of the head and chin or augmenting the inspiratory phase may sufficiently overcome minor obstructions. It is essential that the anesthetist remain acutely aware of the status of the airway to prevent serious respiratory emergencies.

Laryngospasm. One of the most common emergencies during anes-

thesia, particularly since the introduction of the intravenous agents, is laryngospasm. This is a spastic adduction of the vocal cords preventing active respiratory function. A laryngospasm may be partial or complete, but when a spasm occurs, regardless of the degree, the diagnosis is very evident. Previously, this would have constituted a very serious emergency. However, since the introduction of the muscle relaxants, laryngospasm, while still creating an emergency situation, is no longer as serious as it previously was. Laryngospasm occurs most commonly with the intravenous agents and, as a needle is always in place, the relaxant drug can be administered immediately through the same needle. This usually relieves the spasm in a matter of seconds; however, it is always necessary to augment the inspirations, because muscle relaxants will decrease the function of the respiratory muscles.

Laryngospasm may be caused by an irritation to the vocal cords or by an extremely painful stimulus while the patient is in too light a plane of anesthesia. This condition can be prevented by keeping the retropharynx free of blood, mucus and debris and by properly conditioning the patient to any painful stimuli if the operative procedures are to be performed in a light plane of anesthesia.

Obstruction of the airway, regardless of the cause, always constitutes an emergency which must be treated with dispatch. It is wise to do simpler things first and in many instances the mere augmentation of the inspiratory phase may suffice. In more severe cases where the obstruction is mechanical in nature and the patient cannot be adequately oxygenated by positive pressure, a 13 gauge needle should be introduced into the trachea through the cricothyroid membrane to temporarily alleviate the emergency condition.

In extreme emergencies, where death is imminent, a tracheotomy should be considered, for this at such times could be a lifesaving procedure. It should be stressed that the tracheotomy should be performed as a last resort when other methods have failed.

Bronchial Spasm. A respiratory emergency could arise by the occurrence of a bronchial spasm, a spasmodic contraction of the muscular coat of the bronchial tubes characterized by a lower respiratory tract obstruction. This markedly reduces the tidal exchange. Bronchial spasm is caused by a vagal or local stimulation.

The treatment of bronchial spasm consists of administering aminophylline 7½ grs. intravenously, or epinephrine, or other antihistamines if the cause is allergic in nature. Oxygen should be administered under pressure, or oxygen-helium mixtures if they are available.

Low Oxygen Concentration. Respiratory emergencies often arise owing to low oxygen percentages or lowered partial pressures of the inspired gases. This is particularly true when nitrous oxide-oxygen

mixtures are being used, because nitrous oxide is the weakest of the anesthetic agents in use today and it is not uncommon to attempt wrongly to induce and maintain anesthesia by increasing the percentage of nitrous oxide at the expense of the oxygen flow. This may and usually does create a degree of hypoxia which, if allowed to continue, may terminate in a cardiovascular or nervous system emergency.

When nitrous oxide is being used, an emergency may be prevented by making certain that the patient is adequately oxygenated. If this cannot be accomplished by the use of nitrous oxide-oxygen mixtures alone, complemental or supplemental agents should be used.

Apnea. An emergency of significant importance is apnea, or temporary cessation of respiration regardless of the cause. In many instances it may be caused by hyperventilation which may automatically correct itself when carbon dioxide is built up in the tissues. An overdose of the anesthetic agent may produce apnea, particularly if the agent is one of the barbiturates and it is given rapidly intravenously.

In all cases of apnea, if breathing does not start spontaneously within a few seconds, artificial respiration should be maintained until normal respiratory movements are regained. The initiation of artificial respiration should not be delayed as to do so may result in circulatory failure and cardiac arrest.

Cardiovascular Emergencies

On most occasions cardiovascular emergencies occur secondary to respiratory deficiencies. However, they can occur as a separate entity and any patient undergoing a general anesthetic must be closely observed from a cardiovascular standpoint.

Arrhythmias. Disturbances in cardiac rhythm are not infrequent during general anesthesia. These derangements seem to be due to sensitization of the cardiac conductive mechanism, whose pacemaker may shift from the normal sinus node to the lower foci. Certain anesthetic agents such as chloroform, ethyl chloride and cyclopropane are particularly likely to cause these disturbances. Emotional excitement during induction or hypoxia occurring anytime during the anesthetic are contributing factors to arrhythmias. Carbon dioxide accumulation has also been given as a factor in the cause of cardiac arrhythmias.

While an arrhythmia in the dental office may not always be considered a definite emergency, if it does not respond to increased oxygenation and the removal of other possible causative factors, it might be wise to consider the arrhythmia as an emergency and discontinue the procedure if at all feasible.

Cardiac Arrest. Sudden cardiac arrest is one of the most urgent

emergencies and terrifying experiences in anesthesia. It is my opinion that about 100 per cent of all cases of cardiac arrest in dental offices occur secondary to a respiratory complication or an unrecognized oxygen deficiency. To devote time to a discussion of the technique of cardiac massage would be out of order, as I believe that the dental office is not equipped in regard to personnel or material to carry out successfully such a procedure. The best policy would be to take all steps to prevent such a catastrophe; treatment would not then be necessary. I do not mean to belittle cardiac massage, for I have seen lives saved by this procedure. I only stress the fact that it is by no means a maneuver to be taken lightly. Remember that prevention is much safer than treatment.

Nervous System Emergencies

As with cardiovasculár emergencies, practically all nervous system emergencies are secondary to respiratory emergencies. The most common nervous system emergency, cerebral hypoxia, will be manifested by jactitation or convulsions. Deprivation of oxygen for any period of time may cause damaged cells of the cerebral cortex and basal ganglion. The prolonged reaction time following partially hypoxic anesthesia may be termed a nervous system emergency.

The treatment and prevention for practically all nervous system emergencies is adequate oxygenation of the patient. In those cases in which it is felt that some cerebral edema has occurred secondary to the hypoxia, serum albumin may be administered intravenously as an aid in overcoming the edema and preventing more serious cerebral damage.

Very few emergencies can be treated as successfully and rapidly as the nervous system emergencies secondary to hypoxia, provided that they are readily recognized and immediately treated. On the other hand, few emergencies will have such dire consequences and serious complications as the nervous system emergencies which are allowed to remain unrecognized and untreated.

It should be stressed that the onset of nervous system emergencies is not always sudden and demonstrable. A minor degree of hypoxia, if allowed to continue over a period of time, may slowly depress the vital centers so that they may be permanently damaged and incapable of responding to increased oxygenation or stimulation.

The best treatment for any emergency of this type is prevention. The anesthetist should constantly protect the patient against any degree of hypoxia whatsoever and any combination of circumstances tending to create or perpetuate hypoxia should be rapidly eliminated.

Gastro-intestinal Emergencies

The most common gastro-intestinal emergency during anesthesia is vomiting. This can be a very serious emergency, particularly if the vomitus is aspirated or otherwise causes a respiratory obstruction.

Vomiting calls for immediate and prompt action. The head and body must be lowered immediately, and suction should be used to remove the vomitus from the posterior part of the pharynx and the air passages.

This is one particular emergency that is much easier to prevent than to treat. Any patient who is to be given an anesthetic should be without food or water for at least 4 to 6 hours prior to the appointment. This is particularly applicable to dentistry, as I can think of no situation so urgent in dentistry as to warrant risking a lung abscess or even cardiac arrest so that the dental work may be conveniently done at a particular time. If a patient is having severe pain and has eaten recently—within 4 to 6 hours—narcotics or analgetics can be prescribed to relieve the pain and the anesthetic can be given a few hours later.

SUMMARY

The frequency of occurrence of emergencies in the dental office associated with the use of local or general anesthesia is inversely proportionate to the preventive measures taken by the individual dentist. Every practitioner should be cognizant of the untoward situations most likely to occur with the drug or drugs he routinely uses.

The dentist should make every effort to equip his office adequately so that emergencies can be handled with comparative ease. Oxygen and a method of administering it under pressure should be available in every office. An emergency tray containing all the necessary drugs and equipment which might be hastily needed should be prepared so that they are readily available for immediate use.

Adequate preventive measures combined with efficient preparations for treatment should greatly reduce the frequency of emergencies and minimize the untoward sequelae which could follow.

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Controlling Hemorrhage in Exodontia and Oral Surgery

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The possibility of excessive surgical bleeding or secondary hemorrhage exists whenever exodontia and oral surgery are performed. The ideal approach to this problem is the application of basic precautionary measures in order to prevent or minimize abnormal bleeding. After hemorrhage occurs, the problem can reach serious proportions if the technique employed to control bleeding is inadequate. The general practitioner or surgeon must assume the responsibility of hemorrhage control; therefore, it is imperative that he familiarize himself with the principles involved.

PREOPERATIVE HISTORY

A thorough preoperative history is necessary in diagnosing abnormal bleeding tendencies. Patients should be asked if they have experienced serious primary or secondary hemorrhage following previous dental extractions. Individuals who have bled only after the extraction of teeth may have done so because of local factors. When a patient is predisposed to bleeding owing to a systemic condition such as capillary fragility or a defective coagulation mechanism, he will usually have had other experiences of extravasation or hemorrhage. Therefore, patients should be carefully questioned as to their reaction to other injuries and to surgery. Severe bleeding from minor cuts or abrasions and a tendency to bruise easily are significant. It is important to know if there is a family history of abnormal bleeding.

When the history suggests hemorrhagic tendencies, certain laboratory tests are indicated to establish a specific diagnosis. A diagnosis is necessary so that proper preoperative prophylactic treatment can be instituted.

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LABORATORY TESTS

The following tests are commonly used to evaluate the various factors in hemorrhagic disorders. The coagulation time and bleeding time can be determined easily in any office. If a sphygmomanometer is available, the tourniquet test can be performed, also.

Coagulation Time. The blood is obtained by skin puncture on a finger or, if greater accuracy is required, by venipuncture. The capillary tube method is generally used, but a very simple technique consists of placing a few drops of blood on a clean glass slide. A needle is passed through the blood every minute. Coagulation has occurred when fibrin shreds cling to the needle. The normal time is 7 minutes or less. The normal coagulation time for the Lee and White method is 5 to 8 minutes. The coagulation time is prolonged when plasma factors are abnormal.

Bleeding Time. Make a small cut in the lobe of the ear with the point of a scalpel. At ½ minute intervals, blot the drop of blood with a piece of absorbent paper. The normal bleeding time is 1 to 3 minutes. Bleeding may continue for several minutes or even hours when there are vascular or platelet defects.

Tourniquet Test. A sphygmomanometer cuff is inflated around the upper arm to the mean between systolic and diastolic pressure and held for 5 minutes. After the pressure is released, the skin of the forearm is examined for petechiae. Few or no petechiae appear in a normal finding. The appearance of over 10 petechiae in a standard circle (2.5 cm. diameter) is presumptive evidence of vascular or platelet defects.

The remaining tests, which require more elaborate equipment, can be performed by a local medical laboratory or at most hospitals on an out-patient basis. Occasionally, it is advisable to hospitalize the patient so that a complete physical evaluation can be made in conjunction with the blood studies.

Blood Count. Normal values are as follows:

Hemoglobin: 14 to 17 grams
Red blood cells: male—4,500,000 to 5,500,000 per cu. mm.
female—4,000,000 to 5,000,000 per cu. mm.
White blood cells: 6,000 to 8,000 per cu. mm.
Neutrophils, 60 to 70%
Lymphocytes, 25 to 35%
Monocytes, 4 to 8%
Eosinophils, 1 to 3%
Basophils, 0 to 1%
Platelets: 250,000 to 500,000 per cu. mm.

Prothrombin Time. The normal for the Quick test is 15 to 20 seconds. When the plasma prothrombin is diminished, the prothrombin time becomes increased.

Clot Retraction Time. The normal clot begins to retract within an hour after it has formed, and it is completely retracted within 18 to 24 hours. If the platelets are markedly reduced, clot retraction is delayed or absent.

PRIMARY HEMORRHAGE

Primary blood loss in oral surgery is frequently underestimated, especially when the operation is elective and considered to be routine. The results of a study made by this author at Pennsylvania Hospital revealed that the amount of blood lost during certain oral surgery procedures is comparable to losses encountered in general surgery (Table 1). The operations included in this study were performed under general anesthesia.

Extractions

The routine extraction of teeth should not result in bleeding problems in normal patients. (Abnormal patients will be discussed later.) After a tooth is extracted, sharp bone margins should be eliminated, and all bone splinters and traces of pathologic tissue must be removed. The wound is allowed to fill with blood, and a sterile gauze packing is placed over the area and held with firm biting pressure until the blood coagulates. No patient should be dismissed before bleeding has stopped completely.

Proper postoperative instructions are essential in preventing secondary bleeding. The patient must be warned not to suck the wound or probe with his tongue. Mouth rinsing is prohibited until the blood clot has retracted and is firm enough to withstand moderate trauma. This may take up to 24 hours. Strenuous exercise should be avoided. The first meal should be soft, and chewing should be done on the side opposite the extraction site. These instructions are elementary, but it is amazing how frequently secondary hemorrhage occurs because they are neglected.

When several teeth are extracted and an alveoloplasty is performed, primary bleeding increases because of oozing from a larger area of exposed bone and from the periosteum underlying the mucoperiosteal flap. Bleeding is profuse in the presence of pathologic tissue. The extreme vascularity and the hyperemic condition of this tissue results in excessive hemorrhage when surgical trauma is induced. These conditions are well illustrated in Table 2.

TABLE 1. *Blood Loss in Oral Surgery*

OPERATIONS	NO. OF CASES	BLOOD LOSS IN CC. MAX.	MIN.	AV.
Intraoral				
Closure of antro-oral fistula without a sinusotomy	1	—	—	68
Sialolithotomy of submaxillary gland	2	95	49	72
Closure of unilateral cleft palate	2	88	63	76
Cystectomy	20	192	53	118
Odontectomy—impacted teeth*	60	276	62	134
Incisional biopsy of tongue	1	—	—	136
Excision of torus palatinus	8	149	141	145
Excision of central giant-cell tumor of mandible	1	—	—	182
Excision of fibroma in floor of mouth	1	—	—	196
Sequestrectomy of mandible	1	—	—	279
Extraction of teeth				
10 or less	20	241	64	119
11 to 15	20	480	134	261
16 to 20	20	455	150	325
21 or more	20	825	186	465
Cystectomy involving maxillary sinus	1	—	—	494
Sinusotomy and closure of antro-oral fistula	2	705	663	684
Subtotal maxillary resection	1	—	—	915
Bilateral sinusotomy and sequestrectomy of maxilla	1	—	—	1109
Extraoral				
Open reduction of fractured zygomatic arch	2	30	22	26
Excision				
cervical lymph gland	1	—	—	195
submaxillary salivary gland	1	—	—	257
submaxillary tumor	1	—	—	305
Open reduction of fractured mandible				
unilateral	10	663	204	308
bilateral	2	478	396	437
Bilateral ostectomy for reduction of prognathic mandible	2	532	425	478

* Four third molars.

TABLE 2. *Bleeding Rate in Oral Surgery*

OPERATIONS*	BLOOD LOSS PER MINUTE, CC.
Extractions	
no alveoloplasty or periodontal pathology	4.5
alveoloplasty, but no periodontal pathology	5.8
alveoloplasty and periodontal pathology	13.8
Odontectomy	
impacted third molars	4.7
impacted maxillary cuspid	4.1
Cystectomy	
maxillary	7.6
mandibular	3.6
Excision of torus palatinus	3.7
Sinusotomy	11.4
Open reduction of fractured mandible	3.7

* Surgery performed under general anesthesia.

When an alveoloplasty is performed, minute intraosseous arteries which spurt when severed are controlled by crushing bone into the point of bleeding with a blunt instrument. Generalized bleeding from a large surface of bone can be controlled with warm saline sponges or with sponges saturated with a vasoconstrictor. Replacement and suturing of the mucoperiosteal flap should prevent further bleeding. Pressure should be applied by placing gauze packs over the area and having the patient bite firmly.

The total loss of blood is frequently underestimated in multiple extraction cases. This fact is emphasized by making a comparison with a few major surgical procedures. The average loss from the extraction of more than 21 teeth is twice the average for a cholecystectomy. It is approximately 100 cc. more than the loss during a hysterectomy, and it equals the loss during a nephrectomy. The removal of 11 to 15 teeth results in blood loss equal to that in the average thyroidectomy. These data are important because the majority of patients undergoing multiple extractions are in the older age group. These older patients tolerate blood loss poorly, and their convalescence is retarded. The incidence of fluid balance disturbance is high in this group.

Odontectomy

The surgical removal of an impacted mandibular third molar can result in profuse arterial hemorrhage, if the inferior alveolar artery is traumatized. This mishap is not uncommon when the tooth encroaches upon the canal or the canal passes between the roots of the tooth. The hemorrhage usually occurs immediately after the tooth has been removed; therefore, hemostasis can be established by packing the wound with an absorbable gauze sponge. Gelfoam is recommended because it is very effective in arresting this type of bleeding, and it is compatible with normal healing. If an absorbable material is not available, the wound can be packed with cotton gauze saturated with a vasoconstrictor. This method is not advocated, since bleeding may recur when the vasoconstrictor becomes exhausted or when the packing is removed. Bone wax is used by some surgeons.

Surgical bleeding during an odontectomy tends to obscure the operative field. Visibility must be maintained by aspirating or sponging the blood. The average rate of bleeding under general anesthesia, without a local vasoconstrictor, is 4.7 cc. per minute. The duration of surgery depends on the type of impaction and the density of the bone. The average volume of blood lost during the removal of four totally impacted third molars exceeds the average loss for an appendectomy.

Cystectomy

The removal of a cyst creates a large area of denuded bone which bleeds freely. Bleeding can be controlled by inserting a pressure packing of gauze, with or without a hemostatic agent. Some men advocate the use of bismuth-iodoform-petrolatum paste on gauze to promote healing and to act as a lubricant when the packing is removed. Other techniques employ the use of absorbable gauze or bone chips to obliterate the bone cavity. In small bony defects, closure with the mucoperiosteal flap and suturing will suffice.

Miscellaneous Intraoral Techniques

Arterial bleeding from the palatal mucosa can be stopped by placing a suture through the mucosa, around the injured vessel, and tying the suture on the surface. This method should not be used unless it is impossible to clamp the artery at the point of bleeding. Ligating the main artery may result in tissue necrosis, if the collateral circulation is inadequate. When a palatal flap has been raised

and bleeding occurs from the incisive foramen, a peg made from a cotton applicator stick can be inserted into the orifice of the foramen until coagulation prevents further bleeding.

The highest blood losses were measured during procedures involving the maxillary sinuses. The figures in Table 1 are comparable to the average blood losses for radical mastectomies and small bowel resections. The increased rate of bleeding is due to the vascularity of the inflamed sinus mucosa and pathologic contents, and the longer operating time required for these cases. The average loss per minute during a sinusotomy is 11.4 cc. When the surgeon performs both a plastic closure of an antro-oral fistula and a sinusotomy, most of the bleeding results from the latter procedure. This is confirmed by the fact that a closure of an antro-oral fistula, without sinus débridement, resulted in a loss of only 68 cc. of blood.

Bleeding during a sinusotomy can be reduced by packing occasionally with gauze saturated with warm saline solution or a vasoconstrictor. When surgery is completed, a packing is placed in the sinus cavity with one end protruding into either the nasal or the oral cavity. This facilitates the removal of the packing postoperatively.

Hemorrhage from the tongue is usually profuse because of the extensive vascularity of this structure. Bleeding should be controlled by clamping and tying vessels as the dissection progresses. If a large artery is severed accidentally and massive bleeding obscures the area, the flow of blood can be reduced or stopped completely by squeezing the tongue posterior to the wound. The bleeding vessel is located and clamped. This same procedure is used if the dentist lacerates the tongue with a dental instrument.

Extraoral Procedures

The surgeon who performs extraoral operations must be familiar with the anatomy of the area involved. Surgical bleeding from soft tissues can be controlled rapidly and effectively with the use of hemostats. Every bleeding vessel, regardless of size, should be grasped with a hemostat. The smaller vessels may not have to be tied, if the clamp is allowed to remain for a few minutes. The crushing of the vessel and the clotting of blood within its lumen, or thrombosis, prevent further bleeding when the instrument is removed. Larger vessels that are to be tied should be clamped with as little of the surrounding soft tissue as possible. The hemostat is held so that the end is visible, and the ligature material is passed around it and tied once. The hemostat is removed, and a square knot is completed. The ends are cut off close to the knot in order to prevent excessive

tissue reaction during healing. When larger vessels are in the area of dissection, they should be located, identified, and dissected free from the surrounding tissue. Two hemostats are placed, and the vessel is cut between them. The severed ends are ligated and the instruments removed.

Wounds should not be closed until bleeding has been arrested completely. Continuous bleeding within a closed wound may form a hematoma which predisposes to infection. If complete hemostasis is impossible and there is a possibility of continued oozing, a drain should be inserted so that blood will not accumulate in the tissue. A pressure dressing over the operative site is usually advisable in such cases. The drain may be removed after 24 hours, if bleeding has stopped.

Occasionally, it becomes necessary to ligate the external carotid artery or its tributaries in order to control severe bleeding which cannot be arrested by the methods described. This situation is usually anticipated, and the major vessels supplying the operative site can be ligated prophylactically. This is particularly true for extensive resections. The external carotid and lingual arteries may have to be ligated through separate incisions. Other arteries and veins are generally tied when demonstrated in the operative field.

SECONDARY HEMORRHAGE

Secondary hemorrhage may vary from slight oozing to massive bleeding of an alarming nature. When one is confronted with a case of profuse secondary hemorrhage, gauze packing applied directly to the wound will control bleeding temporarily. This is advisable in order to prevent further loss of blood. If the bleeding has been excessive for a long period of time, the patient may become faint and have a weak and rapid pulse. There may be a drop in blood pressure. The skin and mucous membrane will appear pale and cold as shock develops. Appropriate treatment must be started immediately, if there is evidence of acute distress. When the proper facilities are not available in an office, the patient should be hospitalized. A transfusion of whole blood may be indicated in cases of severe blood loss.

Local Treatment

The first step in establishing local hemostasis is the removal of all blood clots to facilitate a thorough examination. The type of bleeding should be recognized. Arterial bleeding produces a spurting of bright red blood; venous bleeding appears as a continuous flow of dark red

blood, and capillary bleeding is characterized by continuous oozing. The bleeding may be due to infection or sloughing of tissue, if hemorrhage starts several days following surgery.

Hemorrhage from a recent extraction wound may come from bone or gingival tissue. Bleeding from bone often requires packing of the alveolar socket. The use of absorbable Gelfoam is recommended. The sponge may be saturated with Topical Thrombin solution in order to accelerate coagulation. When the bleeding is severe, a horizontal mattress suture should be placed across the wound. It may be necessary to trim the alveolar bone so that contact can be made between the opposite gingival margins.

When bleeding arises from the gingival tissue, as is often the case, packing the socket is ineffective. The condition of the alveolar margin should be examined for sharp irregularities. Displaced fragments of bone must be removed. Frequently, gingival bleeding can be localized to granulation tissue which had filled a periodontal pocket and remained attached to the gingiva after extraction. The removal of this highly vascular tissue may stop this type of bleeding immediately. In other instances, when a bleeding gingival vessel can be demonstrated, clamping with a hemostat is indicated. Lacerations should be sutured. If the gingival hemorrhage consists of persistent capillary oozing, biting pressure on a gauze pack may be sufficient. However, the use of local hemostatic agents is helpful in some cases. Vasoconstrictors are used because of their immediate effect, but if adequate clotting does not occur before their effect wears off, bleeding will start again.

After the secondary hemorrhage has been controlled, if hospitalization is not necessary, the patient is instructed to return home and remain quiet by sitting in a comfortable chair. Patients confined to bed should assume a modified Fowler's position with the head raised approximately 10 inches. This reduces the blood pressure locally in the area of the wound. Cold compresses or an ice bag applied to the side of the face and neck aid in reducing blood flow to the area, also. The patient should not take stimulants, and the mouth should not be rinsed.

CONDITIONS PREDISPOSING TO HEMORRHAGE

The problem of controlling hemorrhage is complicated in the presence of a systemic condition which disposes the patient to abnormal bleeding. The majority of the hemorrhagic disorders can be traced to a defective clotting mechanism or an increased permeability of the vessels. Reference should be made to the physiology of blood coagulation, so that the cause and treatment of hemorrhagic diseases will be

better understood. This process is complex, but for practical purposes it can be summarized as follows:

Thromboplastin + Calcium + Prothrombin → Thrombin
Thrombin + Fibrinogin → Fibrin (clot)

All of the substances listed are required for blood coagulation, and a hemorrhagic diathesis may occur whenever any of them is diminished or absent.

Hemophilia

This is a hereditary disease confined to males but transmitted by females. In hemophilia, there is an increased resistance of the blood platelets to disintegration. Consequently, the enzyme thromboplastin is not readily available to initiate the clotting mechanism. The clotting time is greatly prolonged, but the results of all other tests are generally normal. The bleeding time is normal because thromboplastin from traumatized tissue juice is sufficient to produce coagulation in the small wound made when obtaining blood for the test. In large wounds, this source of thromboplastin is inadequate.

The aim of treatment is to supply the deficient factor that is necessary for normal clotting of blood. The absence of a clot results in bleeding of an oozing nature that persists for hours or days. Severe anemia may develop, and a fatal termination is possible, if the hemorrhage is not arrested. Transfusion of whole blood will temporarily bring the coagulation time to normal. The transfusion of 100 cc. of whole blood will reduce the coagulation time to normal for several hours; however, transfusions of 500 to 1000 cc. are indicated in an emergency. The degree of anemia influences the amount of blood required. Whole blood may have to be administered until the tissues have healed sufficiently to prevent further bleeding.

The use of the antihemophilic globulin, fraction I, should be considered. This fraction is made from normal plasma and has been developed for intravenous injection. In many cases, it will reduce the coagulation time immediately. The injections are usually repeated until the wound has healed.

Thrombocytopenic Purpura

This is a hemorrhagic disorder due to a reduction in the number of blood platelets. The normal platelet count is 250,000 to 500,000 per cubic millimeter of blood. In severe cases of thrombocytopenia, the number of platelets may fall below 10,000. The bleeding time is prolonged, but the clotting time is usually normal. This is explained

by the fact that the number of platelets is too small to plug the defect in the blood vessels during the bleeding test, but is large enough to initiate the coagulation mechanism in the blood specimen used for the clotting test. The clot does not retract. The tourniquet and suction tests are usually positive. Patients having this condition may be aware of it because of previous episodes of bleeding or purpuric spots on the skin surfaces. Transfusions of fresh, whole blood are indicated in order to increase the number of platelets. Fresh blood is emphasized because platelets disintegrate in a short time if the blood is stored.

Leukemia

The various types of leukemia are characterized by an increase in the number of white blood cells. There is a decrease in red blood cells and platelets. The thrombocytopenia results in hemorrhagic tendencies. It is not uncommon to find petechiae and purpuric spots on the skin of these patients. Extractions and surgery should be performed only when absolutely necessary. The associated thrombocytopenia is treated, as described above, with transfusions of fresh, whole blood.

Anemia

Blood platelets diminish in number at approximately the same rate as the red blood cells. In hypochromic anemia, the platelets are only slightly reduced. However, the platelet count may be much lower in macrocytic, hyperchromic (pernicious) anemia and in aplastic anemia. In any event, the thrombocytopenia results in a tendency toward hemorrhagic manifestations.

Hypoprothrombinemia

A prothrombin deficiency may be due to a deficiency in vitamin K, an inadequate absorption of vitamin K from the gastro-intestinal tract, or poor utilization of vitamin K by the liver where prothrombin and fibrinogen are synthesized.

A true dietary deficiency of vitamin K is highly improbable because of its wide distribution in food and its synthesis by the normal intestinal flora. Vitamin K is absorbed from the intestine only in the presence of bile salts. In obstructive jaundice and in biliary fistulas, when no bile reaches the intestines, a decrease in the blood level of prothrombin results. If oral vitamin K is administered in these cases,

bile salts should be used, or a water-soluble preparation such as Synkayvite is preferred because absorption is more certain.

If the liver is damaged by such diseases as advanced cirrhosis, severe hepatitis or cancer, the administration of vitamin K will be of no avail. The liver is unable to synthesize prothrombin in these conditions.

Several preparations are available for use in vitamin K therapy. The dosage varies according to the drug used, the existing hemorrhagic condition, and the route of administration. Parenteral administration is advocated, especially, in emergencies. Vitamin K_1 is highly recommended because, in many instances, it has been found to be superior to other vitamin K preparations.

Effects of Anticoagulant Therapy

Anticoagulants are employed in the treatment of myocardial infarction, venous thrombosis, pulmonary embolism, and acute arterial embolism of the extremities. The most commonly used drugs are heparin and Dicumarol, which block the action of prothrombin and the formation of prothrombin, respectively. If an extraction or surgery is indicated during anticoagulant therapy, the clotting mechanism should be restored to normal. The patient's physician must be consulted when this situation arises. Protamine sulfate will restore clotting to normal in heparinized patients, and intravenous vitamin K_1 is used to counteract the effects of Dicumarol. Transfusions of fresh, whole blood may be indicated in some cases.

Effects of Salicylate Administration

Salicylates are related chemically to Dicumarol and will produce hypoprothrombinemia with prolonged use. This fact should be considered when treating arthritic patients who may be on salicylate therapy. A preoperative prothrombin time test will detect this condition, and the administration of vitamin K is effective in restoring the prothrombin level to normal.

Capillary Permeability and Fragility

The function of vitamin C (ascorbic acid) is to maintain the integrity of capillary walls by strengthening the intercellular cement which binds the endothelial cells. Frank scurvy today is rare, but a deficiency of vitamin C can result in weakening of the capillaries, with subsequent hemorrhagic manifestations. The recommended therapeu-

tic dose is 300 to 500 mg. daily. Large amounts may be given without ill effects, as the excess ascorbic acid is eliminated by the kidneys. The synthetic substance can be administered by the oral, intramuscular, or intravenous route.

The bioflavonoid and rutin compounds are also beneficial in the treatment of capillary fragility. Various combinations of these agents are available commercially. Their use is of more value in the preoperative prophylactic treatment of increased capillary permeability than in acute hemorrhagic emergencies.

Hypertension

The rate of surgical bleeding increases noticeably when the patient's blood pressure is elevated. This may present a problem if a local anesthetic solution without a vasoconstrictor is used when the patient gives a history of hypertension. The situation is encountered more frequently with general anesthesia, in the absence of local vasoconstrictors. When surgery is completed, it is necessary to establish complete hemostasis because of the high incidence of recurrent bleeding in these cases. A Gelfoam pad can be placed in the wound and the free soft tissue margins should be sutured, in order to secure the clot.

Menstruation

This is not a definite contraindication for operative procedures, but patients who suffer from such disorders as menorrhagia or metrorrhagia may experience prolonged and serious bleeding postoperatively. Secondary hemorrhage may start as late as two or three days after surgery. Elective extractions and surgery should be postponed when these disorders exist. A medical consultation is advisable.

Pregnancy

It is not unusual to find marked congestion of gingival tissues during pregnancy. Surgical trauma may cause oozing, if the tissues are in this condition. The use of local hemostatic agents is helpful in arresting this type of bleeding.

SUTURE MATERIAL

Suture material should be selected with care. All materials are classified as absorbable or non-absorbable. Absorbable sutures are

those which are absorbed or digested by the body cells and fluids during and after the healing processes. They do not have to be removed. Absorbable sutures are made of catgut, except for a very minor supply of kangaroo tendon. (The name "catgut" is a misnomer. Modern surgical gut is really sheepgut.) Plain catgut, size 2-0 or 3-0, is used in oral surgery for tying small vessels that are buried when the wound is closed. Larger vessels may be ligated with chromic catgut. Chromicized gut resists the digestive action of the tissues and is absorbed much slower than plain gut. This eliminates the possibility of secondary hemorrhage due to rapid absorption of the ligature. When a large artery such as the external carotid is ligated, it is advisable to use silk, which is non-absorbable.

Non-absorbable sutures are not affected by the digestive action of body fluids. When used on the tissue surface, non-absorbable sutures are removed after the wound has healed. When buried in tissues, they remain as foreign bodies. Usually, they become encysted and cause no trouble. The non-absorbable sutures are made chiefly of silk, cotton, linen, metal, horsehair and silkworm gut.

ELECTROCAUTERY

Bleeding from tissues invaded by malignant tumors may be difficult to control. The use of the electrocautery is recommended in most cases. This method not only prevents hemorrhage by sealing lymphatics and blood vessels, but it also reduces the possibility of metastasis. Large vessels may be clamped with a hemostat which is touched with the electrode. The current passes through the hemostat to the bleeding vessel and seals the lumen. This eliminates the need for ligation.

LOCAL HEMOSTATIC AGENTS

Absorbable Sponges. Gelatin sponge (Gelfoam) is highly recommended for use in controlling hemorrhage. Its hemostatic effect results from its action as a matrix supporting the blood clot. When fibrin is formed during the coagulation of blood, it is deposited in the interstices of the matrix and it binds the matrix to the surface of the wound. When implanted in tissue, it is completely absorbed in 4 to 6 weeks. Gelfoam saturated with Topical Thrombin solution has a greater hemostatic action. Capillary oozing or venous bleeding may be controlled instantly with this combination.

Oxidized cellulose produces a specific hemostatic effect when applied to a bleeding area. A coagulum is formed which checks bleeding. Oxidized cellulose inactivates Thrombin solution because of its acidity (*p*H 4). If Topical Thrombin is used, it is necessary to neu-

tralize the gauze by immersing in a 1 per cent solution of sodium bicarbonate. The coarse-meshed oxidized cellulose gauze is very friable and difficult to handle. Its major disadvantage is its slow rate of absorption. Occasionally, the material acts as a foreign body.

The commercial alginate wools and gauzes currently used as hemostatic agents are composed of sodium and calcium alginate derivatives of alginic acid. Hemorrhage is controlled by packing the material into bleeding sockets.

Thrombin. Topical Thrombin is a standardized, sterile hemostatic powder obtained from bovine plasma. It may be applied as a dry powder or in a sterile, isotonic saline solution. Thrombin clots blood directly, by acting on fibrinogen. The application of Thrombin is indicated for stopping hemorrhage from open wounds that cannot be controlled by ligatures or pressure.

Two other noncaustic hemostatic agents which should be mentioned are Thromboplastin solution and Cephalin. The latter is made as an emulsion. Both preparations are applied directly to oozing surfaces.

Vasoconstrictors. Epinephrine and related substances have an immediate but transitory effect. As stated before, if adequate coagulation of blood does not take place in this short period of time, bleeding will recur.

Astringents. These agents produce hemostasis by precipitating proteins. Ferric subsulfate (Monsel's salt) and tannic acid are the commonly used astringents. They form a plug of coagulum over the bleeding wound by precipitating proteins of the blood and the soft tissues. In order to be effective, they must be brought into immediate contact with the bleeding point. If hemorrhage arises from bone deep within the socket, saturated gauze should be packed into the wound. Care must be taken, since astringents can act as irritants.

Miscellaneous Agents. The use of viper venom has been advocated for the control of hemorrhage. Also, Thrombodent cones, containing thrombin and tyrothricin, can be inserted into bleeding sockets. Countless other agents are used; however, many of the older drugs are being replaced by newer and more effective preparations.

SYSTEMIC HEMOSTATIC AGENTS

The systemic administration of coagulants results in various degrees of success. In many instances, a preparation is used empirically without considering its mode of action. For example, calcium gluconate and calcium lactate are often prescribed for the therapeutic effect of calcium. It is true that calcium is necessary for the clotting of blood; but, if there is no deficiency of the mineral, the administration of these salts will not promote hemostasis.

Ceanothyn and Koagamin are coagulants which act directly on the plasma substances necessary for clotting. Ceanothyn, an oral preparation, accelerates the action of thromboplastin. Koagamin mobilizes prothrombin, enabling it to be converted into thrombin for rapid coagulation. Prompt action is obtained if Koagamin is administered intravenously.

Kutapressin and Adrenosem salicylate differ from the coagulants because they have no effect on any of the blood components associated with the coagulation mechanism. Their specific action is that of decreasing capillary permeability. Kutapressin prevents or controls capillary hemorrhage by causing constriction of terminal arterioles and capillaries. Adrenosem salicylate produces an increase in capillary resistance. Adrenosem is recommended only for mild, low-grade bleeding, since it will not control massive hemorrhage.

SUMMARY

Every patient should be evaluated preoperatively, in order to eliminate the possibility of an abnormal bleeding condition. Hemorrhagic disorders can be diagnosed by a thorough history supplemented with laboratory tests and a physical examination, when indicated. Surgery must be delayed until discrepancies in the coagulation mechanism or vascular defects have been corrected. Transfusions of fresh, whole blood may be needed; especially in cases of blood dyscrasias. This method of treatment will prevent serious complications.

Surgical blood loss usually is underestimated in normal patients. Excessive primary bleeding can be prevented by employing sound surgical techniques. The majority of postoperative hemorrhages result from inadequate débridement of the wound, ineffective hemostasis, or failure on the part of the patient to follow postoperative instructions.

The use of local hemostatic agents is helpful in arresting hemorrhage. Gelfoam and Topical Thrombin solution are recommended because of their effectiveness and their compatibility with normal healing. Systemic agents have limitations; however, if the proper agent is selected for a particular situation, it can be of value as an adjunct to other measures in establishing hemostasis.

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Emergency Treatment of Traumatized and Fractured Anterior Teeth in Children

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With the emphasis of our government on physical fitness and consequently the participation of so many more of our youth in athletics, we must be ready to care for any injuries that occur that may be within the realm of our professional responsibility. One of the most frequent emergencies seen in the dental office is that of the traumatized or fractured permanent or deciduous incisor tooth. It is indeed a responsibility to prevent the loss of these injured teeth, for there can be no question of their importance, from both a functional and an esthetic standpoint. Usually emergency care is required and the type of treatment given at that time may have a definite bearing on the prognosis of the case you are called upon to handle.

The toddler, just learning to walk, is uncertain of his steps and in one of his many tumbles may traumatize or fracture his young deciduous teeth. It is not uncommon to see a discolored incisor in a child quite young. As he matures, his games become more strenuous and his chance for injury to the incisor teeth increases. This is especially so in the case of the child with prominent premaxillae and protrusive central incisors, for the most frequent subject for this emergency treatment seems to be the child with "buck teeth." The case is usually complicated by a class 2 malocclusion with a history of thumb or finger sucking. Children suffering from such a malocclusion should receive orthodontic care as soon as possible. Usually the short upper lip does not give sufficient protection to the teeth, and a blow or a fall makes them excellent candidates for injury.

Children who take part in contact sports should certainly wear mouth protectors for their teeth during their participation in such activities. Injury to the cuspids is infrequent because of their morphol-

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ogy, for they are usually of sufficient bulk to withstand external trauma and their position in the arch is such that they are protected by the lips. The same may be said for the teeth posterior to the cuspids.

The sooner the child receives emergency treatment for the injury, the more favorable are his chances of retaining the tooth or teeth. Most parents are aware of the importance of these teeth and for this reason the child is usually brought to the office for treatment shortly after the accident occurs. The child who is suffering from an injury to the teeth is usually in pain and quite anxious about what is to happen. The considerate practitioner will prescribe a sedative to ease his nervousness and calm his fears. Either pentobarbital sodium (Nembutal) or secobarbital (Seconal) may be given using Young's rule $\left(\frac{\text{Age}}{\text{Age} + 12} \times \text{adult dose}\right)$ or Clark's rule $\left(\frac{\text{Weight}}{150} \times \text{adult dose}\right)$ to arrive at the correct dosage for the child.

The decision to be made at this time as to the type of emergency treatment becomes the dentist's most important responsibility. The type of injury governs the treatment to be undertaken, and the considerations outlined in the following pages should assist him in selecting the best procedure to use. Only those situations in which emergency treatment is indicated are discussed.

Information obtained from the case history and from the clinical and roentgenographic examinations called for in the following pages must be recorded so that it will be available for future reference.

FRACTURES OF PERMANENT INCISORS

Fracture of Crown, Little or No Dentin Exposed

Case History.

1. Note the age of the patient. (Remember that this notation is the chronologic age, which may vary from the physiologic age.)
2. How did the accident occur?
3. Has the injured tooth ever received previous trauma?
4. Note any other pertinent data that may have a bearing on the prognosis of the case.

Clinical Examination.

1. Note the condition of the soft tissue. Usually simple fractures are not complicated by severe lacerations of the soft tissue.
2. Note the mobility of the tooth. If the tooth is unusually mobile, splinting might be necessary.

3. Dry the incisors and test the injured tooth, the adjacent teeth and the teeth in the opposing arch with a high frequency vitalometer. If this is not available, a pointed piece of ice may be used to test for vitality. Remember, however, that the injured tooth might be in a state of shock and will not respond to stimuli at the present time.

Roentgenographic Examination. Include in the examination the injured and the adjacent teeth. The teeth in the opposing arch should also be x-rayed as a precautionary measure.

Initial or Emergency Treatment.

1. Check the occlusion and if the tooth has been dislocated, return it to the normal position and/or if it is loose, place a splint for stabili-

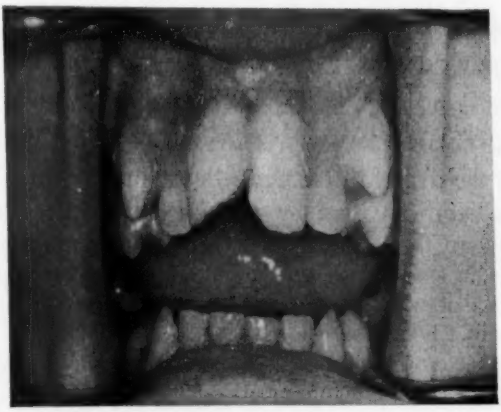

Fig. 1. Fracture due to crowding and protrusion of the central incisors.

zation during recovery. The incisal edge of the teeth in the opposing arch may need to be relieved to prevent constant pounding during mastication.

2. Smooth any sharp or rough edges that may be present with stones or sandpaper disks to prevent lacerations of the tongue and lips. Apply a coat of protective varnish to the fractured area.

Fracture of Crown Involving Considerable Dentin but Not Involving the Pulp

Record the case history and the findings of the clinical and roentgenographic examinations as previously outlined.

Initial or Emergency Treatment.

1. Wash the tooth with warm sterile water, using sterile gauze or sterile cotton.

2. Isolate the tooth and dry it with sterile cotton or with warm air. If warm air is used, do not dehydrate the dentin. Cover the exposed

dentin with sterile gauze or cotton to prevent discomfort to the patient while the next step is being prepared.

3. Cover the dentin with a mix of non-irritating obtundent paste (zinc oxide–eugenol–resin). If the pulp is nearly exposed, a mix of calcium hydroxide and sterile water or anesthetic solution should be placed over the dentin in preference to the obtundent paste. Pressure should be avoided at all times.

4. Cover the capping material and dentin with a non-irritating, rapid-setting cement to the enamel margins of the fracture.

5. Select a crown form of celluloid resin, or steel of correct size and shape and trim it to fit the tooth. Check for the gingival fit and the bite clearance. A pinch band may be made or a copper band may be fitted to the tooth, if these crown forms are not available.

6. If a celluloid crown form is used, perforate it with a No. 5 round bur on the lingual side in three places, at the cingulum and at the mesial and distal incisal angles. This will lock the crown form in place with the cement that extrudes through the holes. Fill the celluloid crown form with a creamy mix of light-colored cement and seat it carefully over the tooth. Check the occlusion for clearance.

7. If a resin crown form is used, fill the fitted form with a methacrylate mix that will match the adjacent teeth and seat it carefully over the tooth. Check the occlusion for clearance.

8. If a steel crown form is used, the labial aspect may be cut to make a window either before or after it is cemented in position. For esthetic reasons the window may be filled with silicate or methacrylate after cementation. Check the occlusion for clearance.

9. Explain to the patient and the parent the possibility of the tooth becoming non-vital and advise the patient to return immediately if pain is experienced. Dismiss the patient and allow an eight week rest period, at which time the patient will return for a vitality check and roentgenograms of the injured tooth.

Fracture of Crown Involving Considerable Dentin with Pinhole Exposure of the Pulp

Record the case history and roentgenographic findings as previously outlined.

Clinical Findings. A small exposure of the pulp with little or no hemorrhage, elapsed time from the moment of the fracture not over 20 hours, vitality reaction with the vitalometer fair to good and no complicating factors, such as intrusion, extrusion, mobility, fracture of the root or soft tissue involvement. If the time of exposure is over 20 hours a pulpotomy should be performed.

Initial or Emergency Treatment: Pulp Capping.

1. Isolate the injured tooth with the rubber dam and swab the external area of the dam and tooth with Tincture of Metaphen or Merthiolate Solution. Do not touch the exposure or dentin.

2. Wipe the exposure and dentin with warm normal salt solution or sterile tepid water on sterile cotton. Do not use caustic drugs.

3. Dry carefully with sterile cotton and cover the exposed pulp carefully with a paste of calcium hydroxide and sterile distilled water. A drop of anesthetic solution may be used if sterile distilled water is not available. Avoid pressure at all times.

4. Cover the capping material and dentin with a non-irritating, rapid-setting cement to the margins of the fracture, and cover the tooth with a crown form as previously outlined.

Fracture of Crown Involving Considerable Dentin with Extensive Exposure of the Pulp

Record the case history as previously outlined.

Roentgenographic Findings. (The decision as to the type of operation to perform rests with the operator, who will predicate it on his other findings in the history of the case.)

1. Open apical foramen and clinical findings noted in (1) above; a pulpotomy is indicated.

2. If the roentgenogram discloses a closed apical foramen, the operator may perform either a pulpotomy or a pulpectomy. If the pulpotomy is performed and it is successful, the tooth will remain vital, which is to be preferred. If it is unsuccessful, endodontic therapy may be instituted at a later date and a non-vital tooth will result. If a pulpectomy is performed, the tooth will be non-vital immediately after the removal of the pulp.

Clinical Findings Indicating Pulpotomy. A large exposure of the pulp with some hemorrhage, elapsed time not over 24 hours, vitality fair to good and no complicating factors.

Initial or Emergency Treatment: Pulpotomy.

1. Anesthetize the pulp using infiltration or conduction anesthesia.

2. Isolate the tooth with a rubber dam. If the fracture extends under the gingiva, construct a band to fit on the tooth to permit the use of the dam. Swab the dam and the external tooth area as before outlined.

3. The area, the instruments, and the stones and burs used in the operation must be sterile. Any break in the chain of sterility will preclude the success of the operation. Open into the pulp chamber through the fracture with a large round bur and gain good access to the pulp.

4. Remove the bulbous coronal portion of the pulp with a sharp excavator or curet approximately 1 mm. below the gingival margin. Observe the condition of the pulp tissue. If it is friable and stringy and there is considerable hemorrhage, the chances of success are lessened and the performance of a pulpectomy should be considered. Place a pledget of cotton over the pulp stump until bleeding stops.

5. Cover the amputated portion of the pulp with about 1 mm. of calcium hydroxide–sterile water paste, without pressure. This mix will appear radiolucent on the x-ray film. A thin layer of zinc oxide–eugenol may be placed over this as a buffer, followed by a thin mix seal of cement. Use no pressure at any time. After the cement has hardened, flush the cavity with hydrogen peroxide to remove the dried blood from the pulp chamber.

6. The fractured corner may be replaced immediately with methacrylate or silicate if the operator so desires, using the bulk of the pulp chamber for retention with an accessory pin for added strength.

Clinical Findings Indicating Pulpectomy. The exposure size is relatively unimportant if the elapsed time is over 20 hours, the apical foramen is closed (root development complete or nearly so), the patient is young and healthy and there are no complicating factors.

Initial or Emergency Treatment: Pulpectomy.

1. Preparation for the operation is followed as previously outlined under *Pulpotomy* (1, 2, 3).

2. Remove the pulp from the root canal with a barbed broach and clean the canal thoroughly. Enlargement of the root canal is usually not necessary in young patients.

3. Control the bleeding and place a measuring instrument in the canal and take a roentgenogram. File the measuring instrument for reference in future treatment.

4. Remove the instrument and place a sterile absorbent point moistened with eugenol or Camphophenique in the canal. Follow with a sterile pledget of cotton and seal in the dressing with temporary stopping and an outer seal of temporary cement.

5. Dismiss the patient and follow with an accepted endodontic procedure at future appointments.

Fracture of Root

Record the case history as previously outlined.

Clinical Examination. Note the health of the patient, the condition of the gingiva and the mucous membrane, the degree of infection, the location of the fracture line, etc.

Roentgenographic Examination. Note the apposition of the root fragments and the position of the fracture line.

Initial or Emergency Treatment.

1. A fracture line at the gingiva. Cementation of the natural tooth into the retained root using a pin in the root canal, after endodontic therapy has been completed.

2. A fracture below the gingival margin precludes successful treatment. This type of injury may be complicated by a crushed crown (Fig. 2). Remove the tooth and the retained root.

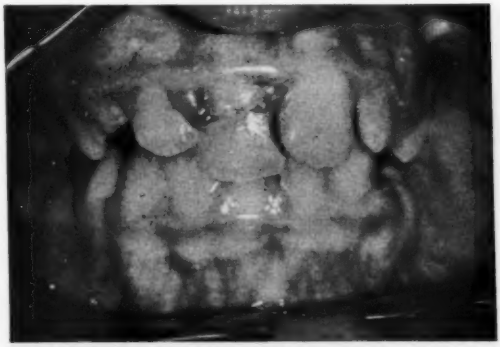

Fig. 2. A crushed permanent central incisor. Extraction is indicated.

3. Wire the injured tooth to the adjoining teeth or construct a methacrylate or surgical cement splint to immobilize the fractured tooth or teeth until healing occurs.

DISPLACEMENT OF PERMANENT INCISORS

Record the case history as previously outlined.

Clinical Examination. Note the amount of soft tissue involvement, laceration of lips, etc.

Roentgenographic Examination. Look for a fracture of the labial plate of the maxillae, and note the condition of the teeth approximating the socket.

Initial or Emergency Treatment. The degree of displacement controls the type of treatment. If it is serious and the teeth are far out of position, their removal and the débridement of all splintered bone may be indicated. Check the roentgenographic findings. Soft tissue involvement may require antibiotic therapy. The possibility of the necessity of tetanus prophylaxis should not be overlooked.

Slight Displacement. If the tooth or teeth are slightly intruded or extruded, they may be manipulated into position under a general anesthetic and splinted into their normal position. The teeth may be wired or a methacrylate or a surgical splint may be used. A warm

saline mouth wash and a soft diet are prescribed and good oral hygiene is stressed. Vitamin therapy should also be instituted and the patient warned that endodontic therapy will be necessary after the teeth have tightened.

Reimplantation after Total Displacement. If more than 4 hours have elapsed since the accident occurred and the tooth is contaminated and unclean, the prognosis is poor. However, if the patient is seen shortly after the injury, the following procedure may be successful in maintaining the tooth in function for some time. Cover the tooth with sterile gauze saturated in saline solution and, while holding the

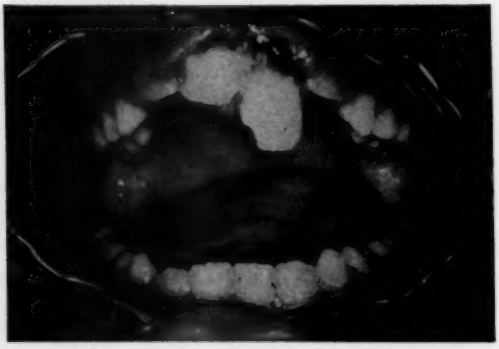

Fig. 3. Fractures of the permanent central incisors with extrusion and intrusion, involving the soft tissue and labial alveolar bone.

tooth in the gauze, open into the pulp chamber through the cingulum. Broach and clean the canal thoroughly but do not disturb the fibers that cling to the pericementum. Fill the canal with a root canal cement and gutta-percha points as would be the procedure under an ordinary root canal filling. Make certain that the apical foramen is sealed and that the external root surface is clean of dried blood and debris. Isolate and swab the traumatized area with Merthiolate Solution and, after freshening the socket, gently place the tooth in the socket without pressure and splint or wire it in position. Check the lower teeth for possible trauma and relieve the bite if necessary. Take a roentgenogram for your records. Resorption of the root will probably occur but the patient will have the use of the tooth for at least a while.

FRACTURES AND TRAUMA OF DECIDUOUS INCISORS

Record the case history and the findings of the clinical examination, as previously outlined.

Roentgenographic Examination.

1. Intruded. Check the position of the deciduous tooth in relationship to the permanent tooth bud. If the intruded tooth is in good position, it will probably re-erupt into the oral cavity. The area should be roentgenographed at regular intervals. The intrusion of a deciduous incisor may cause a dilaceration of its permanent successor or, because of the disturbance of the remnants of the epithelial sheath of Hertwig, a radicular cyst may form (Fig. 4).

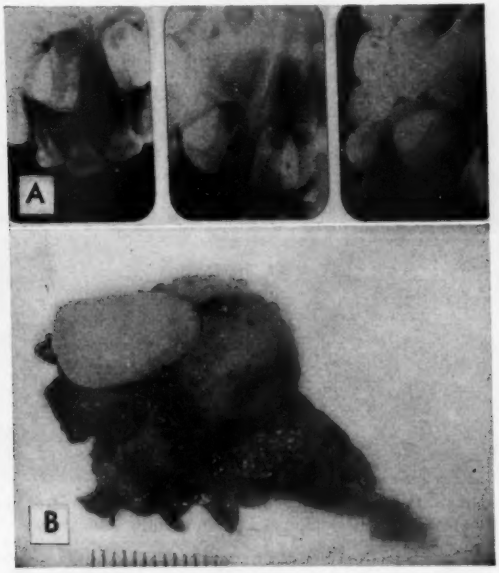

Fig. 4. Cyst involving the permanent left central incisor. *A*, The deciduous left central and lateral incisors are intruded and the tooth bud of the permanent central incisor has become involved. *B*, Photograph of cyst shown in roentgenogram (*A*).

Note the amount of resorption of the deciduous root and the amount of calcification of its permanent successor.

2. Apical radiolucency of a traumatized tooth without displacement. Extract the injured tooth.

Initial or Emergency Treatment.

1. Fracture of the crown with a pulp exposure. Extraction of this tooth is usually indicated. However, if the patient is quite young and the tooth is needed for several years, a pulpotomy may be performed. If the root is also fractured, extraction is indicated.

2. Traumatized. If the tooth is intruded into the alveolus, but the root is not fractured, observation is usually the best procedure, for these teeth often re-erupt in the young child (Fig. 5). Prescribe a warm saline mouth wash; if there is some soft tissue involvement, antibiotic therapy may be indicated. The child is placed on a soft diet and vitamin therapy prescribed.

3. Extruded. Usually unfavorable and extraction of the tooth or teeth is indicated.

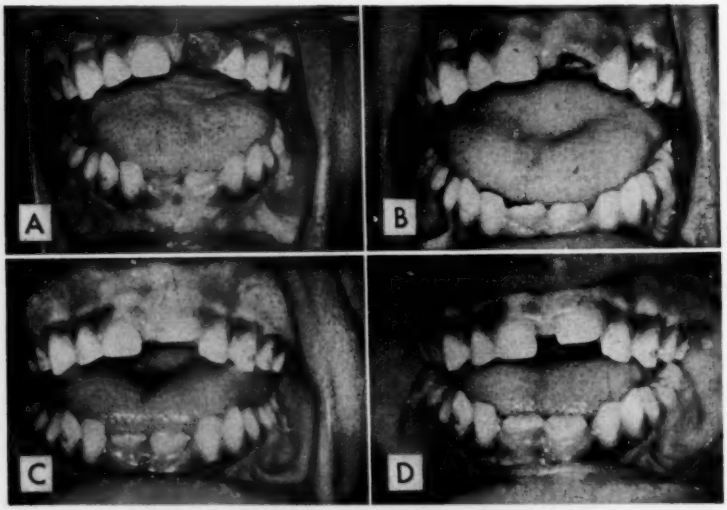

Fig. 5. Intruded deciduous left central incisor. *A*, Soon after injury; *B*, two weeks later; *C*, one month after injury; *D*, two months after injury.

4. Total displacement. A warm saline or bland mouth wash with a soft diet is prescribed. The extent of the injury will govern the necessity of a more involved treatment pattern.

INJURIES TO INCISORS FROM BLOWS

There are other types of injuries to the incisors that are in need of emergency care and should be given consideration. Whenever an incisor receives a blow, whether it be light or heavy, there is sure to be a reaction in the pulp tissue and the degree of severity of the blow and the ability of the pulp to recover from the inflammatory changes that may occur in its tissue will govern the future of the tooth. For instance, if there is good collateral circulation in the pulp of a young immature incisor that has received a traumatic injury and that demon-

strates roentgenographically an open foramen, if the pulp is not exposed, if the tooth is not dislodged and if the patient is seen shortly after the accident for emergency care, the prognosis should be excellent.

However, a mature incisor, be it deciduous or permanent, with a closed apical foramen, may become non-vital from the most superficial blow. This type of injury may not be seen by the dentist at the time the accident occurs. The pulp tissue degenerates, the tooth becomes sore to percussion, swelling may occur and the patient may become febrile. Emergency treatment in this case is urgent.

Sedate the patient, administer anesthesia if necessary, and prepare a cavity at the cingulum of the infected tooth into the pulp chamber for immediate drainage. Relief should be almost instantaneous. Prescribe a warm saline mouth wash and external application of cold packs to the area, and institute antibiotic therapy.

SUMMARY

The prognosis of a fractured or traumatized incisor depends to a large degree on the initial treatment decided upon by the operator when the child is first seen in the office.

Judicious emergency care, followed by adequate treatment at future appointments, should avoid the loss of these injured teeth except in the most unusual circumstances.

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Removal of Fractured and Embedded Tooth Roots

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It is probable that root recovery is the most frequent non-routine procedure that the general practitioner is called upon to perform in the field of exodontia.

This fact is illustrated strikingly by the Mayo Clinic's L. T. Austin and P. T. Waggener in their reported roentgen findings in a series of 1948 edentulous jaws. Of 568 patients who were edentulous in both upper and lower jaws, 27.4 per cent had retained roots. Of 748 patients who were edentulous in the upper jaw, 15.5 per cent had roots remaining, and of 64 patients who had lost all mandibular teeth, 15.6 per cent had evidence of root fragments. In similar series Earle S. Smith reported positive findings in 22.4 per cent while H. M. Swenson relates an incidence of 31.23 per cent.

For purposes of clarification let us regard the term "fractured root" as applying to an occurrence of relatively recent origin or at least prior to complete bony regeneration of the socket; "embedded root" will imply that healing has been complete. In the case of a fractured root we may be reasonably sure that the body shown in the preoperative film is actually a root; the operator dealing with a suspected embedded root may be deceived by three other structures which at times may simulate closely an actual root fragment:

The enameloma, dense and spindle shaped, is usually found in the upper bicuspid and molar area and is characterized by a vertical long axis. It may be surrounded by a fine line of radiolucence which resembles a peridental membrane, but in no case can a pulpal system be demonstrated.

The cementoma (which with the enameloma comprises the only two neoplasms indigenous to the mouth) is ovoid, has a horizontal long axis and is usually found in the mandible. Somewhat less dense

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than the enameloma, it shares its absence of pulpal shadows and its possible presence of a structure resembling the peridental membrane.

A small area of osteosclerosis, or bone whorl, is of inconsistent density, never circumscribed and always devoid of pulpal shadows.

What, then, are the positive identifying criteria of the actual root fragment? There are three, although in each certain influencing factors may make immediate recognition difficult. They will be considered in order:

1. A root fragment will exhibit the anatomic shape of a root, except in that area where a fracture line will be apparent. In cases of long standing, however, the sharpness of the fracture line may be somewhat reduced by chronic disease and the erosive action of pus.

2. Shadows of the peridental structures will be demonstrated. Recognition in the elderly patient may be complicated by the fact that advancing age reduces materially the thickness of the peridental membrane while extreme calcification of surrounding bone may blend with and somewhat obscure the identity of the lamina dura.

3. In an actual root fragment the canal may be demonstrated. Again, age is a modifying factor. In the young adult we may expect a sizable root canal, but with advancing years and the proliferation of senile dentin its size may be greatly diminished and the x-ray shadow may require magnification for recognition.

When the fractured or embedded root has been positively identified the operator is faced with the vital decision as to whether or not the fragment is to be removed. Unfortunately there are those who feel that to leave a root remaining in the jaws constitutes nothing less than heresy. With a sincere and genuine respect for the opinion of others, this observer, whose practice is limited to oral surgery, must plead guilty of being a heretic and must therefore anticipate the shower of stones certain to be hurled from less tolerant quarters. An explanation is in order:

Unless the patient is critically ill, or otherwise a poor surgical risk, from causes *other than oral sepsis,* it is felt that all fragments exhibiting actual pathosis are to be condemned and removed with dispatch. Conversely, when no pathosis can be demonstrated and the patient enjoys excellent health there are factors which would brand root removal with poor surgical judgment and complete disregard of the patient's welfare. Let us consider some of the most significant.

If the relationship of the root fragment with the maxillary sinus is such that there is a reasonable chance that the sinus may be opened in removal or, worse still, that the root may be displaced into the cavity, the considerate surgeon will not remove the non-diseased fragment. It is more practical to allow the fragment to remain undisturbed in anticipation of its working down into safer territory where

subsequent extraction would be less hazardous. A similar situation holds for root tips of the lower third molars in intimate association with the mandibular canal.

Consider, too, the non-diseased root tip which lies under a well functioning prosthesis. If surgical intervention is calculated to result in construction of another prosthetic device the patient pays dearly for a service from which he derives no benefit. A more practical attitude would dictate that the root be removed at a time to coincide with the reconstruction or rebasing of the prosthesis. So then each root fragment need not call for surgery. Consider all aspects carefully. If the possible benefits to be derived overshadow any possible risks, condemnation is indicated. If the reverse is true, good surgical judgment suggests deferment with frequent observation.

Assuming that positive diagnosis has been made and that removal is indicated, the operator next considers technical procedure. As each indication is a situation unto itself it is difficult to generalize and to formulate a universal plan which in every case will elicit best results. Instead the mouth can be divided into several separate areas which because of slight, though distinct, anatomic variations will yield optimal results by varied techniques.

THE LOWER MOLAR AREA

This region, characterized by a dense, thick buccal cortical plate, is best invaded through the more yielding alveolar ridge in the removal of an embedded root. In removing a fractured root the same pathway is indicated but is somewhat more accessible owing to an open operative field and the usual presence of one empty root socket. Should the postoperative film show that the intact root structure is not complicated by dilaceration it is usually a simple maneuver to approach the fractured fragment from the empty socket by appropriate instruments which cut through the alveolar bony septum and engage the root, and then to elevate it upward and out through the orifice of the socket.

In selection of instruments for this purpose, the operator has many choices. Originally the broad, triangular-bladed Cryer elevator enjoyed great popularity, but it is rapidly being superseded by a sharpened thinner-bladed tool which is not unlike a cutting needle used in general surgery (Fig. 1). Advantages of the latter are that the bony septum is cut, not crushed or avulsed, and that a better purchase is afforded on contact with the root to expedite its upward elevation.

Occasionally in a distal root fracture of a lower molar, the fractured fragment may exhibit a marked distal curvature or dilaceration. In such cases the preceding technique is useless inasmuch as the

curved fragment is ineffectually compressed against bone and no displacement is possible. In such cases a sharp Crane pick (Fig. 2) may be sunk into the surrounding bone just distal to the fragment to provide a point of entry for the elevator blade. Pressure applied from the distal aspect now dislodges the fragment with an unhooking action in conformity with the contour of the broken root, and delivery is simplified.

For the embedded root in this area the technique is similar except for the fact that the formerly empty socket, now healed, must be surgically reinstituted after adequate gingival flap reflection. In completely edentulous jaws an incision is begun to bone approximately an inch behind the estimated site of the root along the crest of the ridge.

Fig. 1.

Fig. 2.

Fig. 1. The broad-bladed Cryer elevator is shown at top left. The instrument at the bottom right is sharper and more efficient.

Fig. 2. The Crane pick is shown at top left. An osseous reamer is at the lower right.

It is carried well forward and terminated with a slight deviation toward, but not to, the mucobuccal fold. A periosteal elevator now reflects the flap downward and backward. Those who may consider this step as too heroic are reminded that lack of access hinders even the best surgical endeavor, that a long incision heals just as rapidly as a short one, and that the replaced flap will rest on an ample berth with no danger of the gingival tissue collapsing into the surgical cavity. Where teeth are present, all posterior edentulous areas are incised along the alveolar crest and all interdental gum septa are severed in their buccal aspect forward to the cuspid area. The flap is reflected downward and laterally, affording equally good access in a purse-like manner.

With a sharp osseous reamer (Fig. 2) the bone is entered slightly buccal to the alveolar crest at a point immediately mesial, or distal, to the root, and excavation is continued with an awl-like motion to the estimated depth of the root. The surgical opening may now be

enlarged to any size deemed necessary for efficient instrumentation. With the elevators previously described, the yielding honeycombed medulla may now be easily explored until the root is encountered, at which time it is removed in the same manner described earlier. An antibiotic ointment or pellet is now inserted into the cavity and the flap is returned to its original position. Sutures are usually unnecessary.

Of importance, though of infrequent occurrence, is the removal of a lower third molar which inspection reveals is incomplete, yet from which no remaining root fragment can be visually demonstrated in the socket. A fully diagnostic x-ray film must be made immediately and will usually reveal the fragment which, consistent with visual inspection, is not in the socket. It must be recalled that the lower third molar usually occupies a bony balcony bounded inferiorly by the cavity in which rests the submaxillary salivary gland and posteriorly by the lateral flare of the mandible in this region. The posterior root is therefore covered by an extremely thin lingual cortical plate or may actually project through it. Because of this the lost root tip may be found at rest beneath the soft tissue on the medial surface of the mandible yet completely outside the bone. Because of proximity to the lateral pharyngeal space, immediate removal is mandatory.

The root must be immobilized with finger pressure on its inferior aspect to prevent downward and backward displacement. Adjacent interdental gum septa are severed on their lingual aspect and a sagittal incision is made through the retromolar pad. Without withdrawal of the immobilizing finger the mucosal flap is reflected lingually. If the root can be directed forward and upward into a superficial position it may be recovered with a mosquito hemostat. If this is impossible a flexible silver probe may be bent into a sickle-shaped curve and used to sweep out the root in a from-behind-forward motion. Local application of an antibiotic and placement of a suture through the retromolar pad conclude the procedure, although the patient must be warned to expect unilateral soreness of the throat which usually terminates in 36 to 48 hours.

THE LOWER BICUSPID AND ANTERIOR TEETH

In contrast to the lower molar area, that of the bicuspid and anterior teeth is rather thin in buccolingual and labiolingual dimension, hence the crest of the alveolar ridge, never thick, must be treated with respect in view of existing or future prosthesis. Damage to the contents of the mandibular canal offers no problem except when second bicuspid root tips lie in close proximity to the mental foramen. The external cortex offers an excellent avenue of surgical approach

and thus precludes any damage to the alveolar ridge. The teeth, usually single rooted, seldom show marked dilaceration.

Removal of the fractured root tip may be effected by the Crane pick by the simple expedient of penetrating the relatively thin buccal or labial cortex without preliminary incision. At a point estimated to coincide with the root apex the point of the instrument is allowed to penetrate the mucosa and engage the cortical plate. With an awl-like motion the cortex is penetrated and the medulla entered. Using the hole through the cortical plate as a fulcrum, the tip of the pick is raised by depressing the instrument's handle, thus forcing the root fragment toward the orifice of the socket. Damage to the mucosa consists of only a puncture wound and requires no suture. Healing is usually uneventful, owing to the slight degree of bony manipulation required.

Extraction of the embedded root, while not facilitated by the presence of an open socket, demands even more respect for the integrity of the alveolar crest because of the partial resorption of the structure during the previous healing process. Here again the buccal or labial cortical plate presents the most logical surgical approach. Incision and reflection of the gingival flap are effected in the same fashion as for the molar area, with due regard for the mental foramen and those structures emerging from it. The osseous bone reamer, as before, is chosen as the instrument best adapted for the removal of the obstructive cortical plate and any medullary bone necessary to provide sufficient access, while the Crane pick serves admirably as a means of displacing the root fragment prior to delivery.

After local antibiotic therapy the flap is returned to its original position. In this area flap replacement for both the completely and the partially edentulous mandible is best followed by one or more sutures, as labial activity tends to displace the returned flap unless it is adequately secured.

THE UPPER MOLAR AND BICUSPID AREA

A diagnostic preoperative film, important in the removal of all roots, must be considered doubly so in the upper posterior areas so that the operator may correctly evaluate relationship of the root fragment to the maxillary sinus. Of the four nonpathologic extensions of this cavity, two are of special interest.

Alveolar extension occurs at the expense of the alveolar process (Fig. 3). Beginning at early adolescence this enlargement is usually more pronounced in the first molar area but is not necessarily confined to that region. Indeed, extension into the alveolar process of the

tuberosity, separately regarded by some investigators as the tuberosity extension (Fig. 4), not only occurs frequently but constitutes a surgical hazard to be encountered during alveolectomies of the tuberosity as well as removal of fractured or embedded root fragments. An accurate concept of the degree of alveolar extension is imperative and

Fig. 3.

Fig. 4.

Fig. 3. Alveolar extension of the maxillary sinus.
Fig. 4. Tuberosity extension of the maxillary sinus.

sometimes may be obtained with greater precision by the extraoral lateral film of the jaws (with the same technique as that for a lateral skull film) than by the usual intraoral projection.

The palatal extension will be considered in the discussion of root removal in the anterior maxillary area.

In root fractures in the upper molar area the operator will be called

on to remove one or more separate roots or the intact root structure if the fracture line has occurred below the trifurcation. In the latter situation the elevation of a buccal flap will allow the entrance of a Crane pick between the buccal roots and their subsequent separation by fracture. In all cases one buccal root will be completely detached, not only from its fellow but from the palatal root as well. It will be quite loose and may easily be removed with a small beaked rongeur (Fig. 5). With greater access provided, the Crane pick will now easily detach the remaining buccal root from the palatal. It, too, is removed in the same manner, leaving the palatal root remaining. The palatal root will present a rounded, not flattened, appearance and is quite

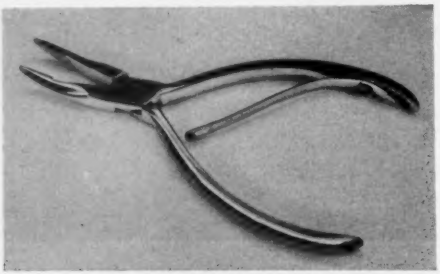

Fig. 5. A small, thin-bladed rongeur well suited for root removal.

sturdy. The beaks of the rongeur are now placed astride the root structure, one beak resting in the cavity formerly occupied by the buccal root, the other forced upward between the palatal mucosa and the palatal cortical plate. Closure of the beaks with a back and forth rotary motion will deliver the root in a manner not unlike the simple extraction of an upper central incisor, provided the beaks are small and the instrument sharp.

Should one or more separate roots remain following attempted extraction they will usually be found rather loosened in the open socket owing to the relatively greater force needed to deliver an upper molar, and in many cases they can be teased out by an exploring point. The use of more heavily designed "root picks" is not encouraged because of their ability to transmit enough force against the fragment to force it upward into the sinus. In cases of roots tight enough to resist the action of an exploring point the small beaked rongeur may again be employed in the same position described for palatal root recovery, that is, engaging the remaining root through an empty root socket and the adjacent cortical plate. It is well to force the rongeur upward sufficiently high to get a good grip on the root. Remember that destroyed bone will be regenerated, that the molar ridge is

broad and thick, and that most persons have little difficulty wearing an upper denture, even under adverse conditions. Above all, remember that heroic bone removal is far preferable to a root in the maxillary sinus.

Recovery of the embedded root, or roots, demands an equal amount of regard for the proximity of the maxillary sinus. Incisions and flap retractions are made in essentially the same fashion as before, with emphasis on sufficient access to preclude the operator's "working through a buttonhole." Again the small beaked rongeur is found to be the instrument of choice, not only to gain bony access but for actual withdrawal of the root fragment. The cortical plate, usually thin, may be removed with dispatch while medullary bone is relatively poorly calcified compared to that of the mandible. Local antibiotic therapy will probably be useful; sutures are rarely, if ever, required.

Recovery of either a fractured or an embedded upper bicuspid root may be effected by the same approach and instrumentation as in the molar area. If anything the problem is somewhat lessened by easier accessibility, a lesser degree of calcification and the preponderance of single-rooted teeth (only about 60 per cent of the first bicuspids are double rooted; the second bicuspid is rarely so). Again, the maxillary sinus is an ever-present consideration.

ROOT RECOVERY FROM THE MAXILLARY SINUS

Displacement of the upper root tip into the maxillary sinus is one of the most distressing accidents in the extraction of teeth. The situation is made even more embarrassing by the usual lack of confidence of the general practitioner in his own ability to cope with the problem. The root is either clumsily removed or allowed to remain, either of which invites sinus disease which demands surgical management by more competent hands. Contrary to the popular dental opinion of several years ago, the root socket and sinus opening must *not* be enlarged for access, because, first, access is not improved to a practical degree, and secondly, chances of an oral-antral fistula are greatly heightened by this approach. Instead the orifice should be immediately occluded with an absorbable gelatin sponge and the socket should be sutured tightly. Depending upon the decision of the operator, the root is delivered via the Caldwell-Luc approach immediately or the patient is referred to a competent otolaryngologist for the same procedure.

Factors affecting the decision are the ability and previous experience of the operator, the history of previous sinus disease and the customary attitude of the community regarding the performance of

such procedures by a dental surgeon. If the operator is familiar with the procedure, if there is reason to believe that no antral pathosis exists, and if there are dentists in the region who routinely perform the operation, the operator may proceed with impunity.

The Caldwell-Luc approach through the thin bone just above the bicuspid roots offers the surgeon greatest dispatch, accessibility, and uneventful recovery combined with adaptability for use at the dental chair. With minor variations recovery of the root fragment becomes a comparatively simple procedure uncomplicated by blind probing and other traumatic manipulation which contribute to undesirable postoperative sequelae.

Fig. 6.

Fig. 7.

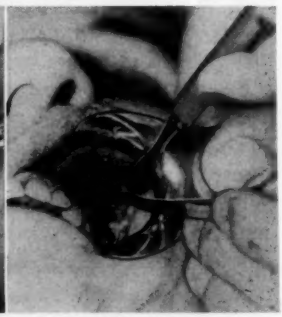

Fig. 8.

Fig. 6. The customary Caldwell-Luc incision is shown by the solid line. The dotted line depicts a preferable approach.

Fig. 7. The modified Caldwell-Luc flap is elevated.

Fig. 8. Removal of root fragment through the surgical opening with a straightened pair of cotton pliers.

The Caldwell-Luc operation classically begins with a semilunar incision in the bicuspid region with its concavity directed upward (Fig. 6). It is rather obvious that an incision of this type offers only a meager bony shelf on which the flap may rest after approximation. With this disadvantage it must be considered that the location of the incision subjects it to traction with every movement of the adjoining facial muscles. Instead, access may be gained more rationally by inserting the scalpel at the gingival margin in the region of the lateral incisor and carrying it boldly upward into the mucolabial reflection. Interdental gingival septa are now severed posteriorly to, and including, the septum between the first and second molars. After reflection upward the flap will be found to be sufficiently distant from the subsequent antral opening to insure perfect closure on replacement (Fig. 7).

The area of minimal bony thickness is now located approximately a

quarter inch above the tip of the second bicuspid. Slight pressure on a Crane pick is sufficient to force entrance, and leverage on the instrument will readily sever an adequate amount of thin bony plate for subsequent manipulation. A small beaked rongeur is now used, with due regard to the proximity of the bicuspid roots, to cut away a sufficient quantity of the surrounding bone and provide an adequate view into the sinus. During the entire procedure, a suction tip is used to prevent hemorrhage of the external soft tissue from invading the sinus. Under no circumstances should the surgical bur or chisel be used to gain entry, since small bits of bony debris reaching the sinus membrane are not only difficult to remove but also are certain to cause postoperative inflammation of the structure if allowed to remain.

Because of the easy access provided by the preceding technique, recovery of the root tip is simple. Under no circumstances should its delivery be effected by flushing the cavity with an irrigating solution, since this procedure removes the protective serum of the membrane. A more satisfactory measure is to grasp the tip with a pair of cotton pliers, the beaks of which have been straightened to make the instrument a more efficient one for this endeavor (Fig. 8).

If the operator has worked with efficiency, no external blood or debris will have found its way into the cavity. Any small blood clots from the original accidental opening are allowed to remain for later resorption. No dressing is inserted but the flap is returned with dispatch, thus effectively sealing the sinus against all external influences. Sutures may be removed after the first 48 hours of convalescence.

THE UPPER ANTERIOR AREA

Embedded fragments in the upper anterior portion are encountered infrequently, owing to the accessibility of the area and the ease of removal. Fractured roots present no great problem for the same reason. Remember that the labial plate must remain intact whenever possible unless a partial resection is to be done for esthetic reasons, and that in partial restorations, artificial teeth are frequently made to fit into the orifice of the freshly vacated socket. For this reason an anterior elevator can be used to produce splendid results (Fig. 9). This thin, concave-bladed straight tool is inserted between the root and the cortical plate on the lingual aspect and firmly directed upward. As no two objects can occupy the same space at the same time, the fragment is readily displaced. Healing is rapid and the patient rarely encounters any appreciable postoperative discomfort.

In the cuspid area diagnosis may be confused by a palatal extension of the maxillary sinus (Fig. 10). Like the alveolar and tuberosity

extensions, this implies a non-pathologic local enlargement of the antral cavity. The involved area is directed medially between the cortical plates forming the hard palate and the floor of the nose, a position greatly distorted by projection in the cuspid film. In it the

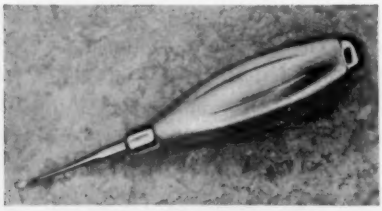

Fig. 9. An anterior root elevator.

Fig. 10. Palatal extension of the maxillary sinus. Note that the cuspid root tip appears to lie within the sinus cavity.

cuspid root is superimposed upon the shadow of the palatal extension so that the root appears to be actually protruding into the maxillary sinus. This is anatomically impossible, and the operator called on to remove a cuspid root tip may be assured he is working in safe territory.

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The Dentist's Role in the Management of Foreign Bodies

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The subject of foreign bodies is not usually considered as an entity deserving separate study. Yet, management of the problem requires unusual considerations. Some foreign bodies constitute an immediate hazard to life. Others produce unusual tissue response, resulting in reactive lesions most difficult to diagnose. Other foreign bodies may produce no symptoms but may have been introduced by the dentist himself, raising the question of an operative procedure in the absence of symptoms; such a procedure may be justified by the psychic response of a hypersensitive patient, the medicolegal aspects of the problem, or the dentist's own estheticism.

The foreign body rarely presents as a true emergency. Hemorrhage, infection, oral-antral communications and similar anomalies, when associated with foreign bodies, are usually secondary to tissue damage, and removal of the foreign body itself is merely incidental to the repair of the injured tissue. The one emergency directly attributable to the presence of a foreign body in the dental field is acute airway obstruction. If he so desires, the dentist has time to refer most problems to a specialist but he cannot refer this one. Thus, the management of obstruction has little in common with the management of non-obstructive foreign bodies and the two subjects will be discussed separately in this article.

AIRWAY OBSTRUCTION

Adequate management of obstruction is based on knowledge of the anatomy and physiology of the airway. The dentist spends his professional lifetime working in the airway and should know the field he is working in.

To simplify the discussion, the mechanics of obstruction are shown by an autopsy specimen recently obtained at this hospital. A middle-

aged man suddenly arose from a meal at a restaurant, brushed other patrons aside, dashed into the street and shortly died. Figure 1 shows how a large piece of beefsteak, extending from the orifice of the esophagus, completely occluded the larynx during inspiratory efforts. The larynx is not physically damaged.

Death attributed to obstruction during dental procedures is rare although most dentists have heard of an incident or two. Such rare tragedies are not due to a lack of basic knowledge but to a failure to prepare for the emergency. Perhaps there are dentists who have never

Fig. 1. Beefsteak occluding larynx during inspiration.

had cause to be grateful for the natural defenses against obstruction. They have never seen a tooth, a filling, or a piece of impression compound slip pass the fauces into the pharynx, watched the patient cough, and then gratefully observed the foreign body reappear in the mouth. Those of us who have had such experiences can do two things in addition to being grateful: We can admit that foreign body obstruction can happen in our own practices, and we can prepare ourselves by periodically reviewing the procedures of management and by maintaining the essential equipment immediately at hand.

Management is accomplished by one or a combination of four definitive measures: (1) The operator may assist the patient in his own natural defense against obstruction although, with the exception of suctioning away regurgitated fluids, such assistance may have little practical value. (2) He may compensate for decreased aeration by

supplying a concentration of oxygen, an ineffectual treatment unless the obstruction is incomplete. (3) He may remove the foreign body. (4) He may bypass the point of obstruction by providing a secondary airway.

Natural Defense against Airway Obstruction

Coughing, swallowing, gagging, regurgitation, the protected location of the larynx and the ciliated epithelium lining the respiratory passages are the chief natural defenses against foreign body obstruction. Since innumerable foreign bodies enter the airway in a lifetime, these defenses presumptively are highly efficient. As in the case described above, the obstructed individual will not seek aid but, rather, will actively resist it in the fear that the helper may only interfere with his own defense. Thus, in the first stages of obstruction in a conscious patient, the dentist's actions necessarily are a compromise between what he would like to do and what he is able to do.

Some objects, because of their size, shape and location, may possibly be removed without the patient's cooperation. In the case described, anyone aware of the nature of the obstruction and physically able to overpower the individual could have reached thumb and forefinger behind the tongue and removed the beefsteak. But in other instances, an attempt to force a struggling patient to submit to instrumentation of the pharynx or larynx will likely make matters worse and waste precious time. In such cases, the dentist should maintain psychological control by assisting the patient in his natural defensive efforts. Gravity may be enlisted by inverting the child patient and bending the adult over in the chair. The time-honored slap on the back probably has real merit in stimulating a cough and increasing its force. A smooth-tipped laryngeal suctioning canula may be introduced past the tongue fairly deeply into the pharynx, even blindly, to assist in carrying away fluids, and few patients will resist this obviously helpful instrument. During this period, the dental assistant, if adequately trained, can assemble the equipment necessary for the emergency if the patient's efforts fail.

Since the patient's defenses are primarily under conscious control, a beginning loss of consciousness is the sign that immediate and more positive action is required of the operator.

Oxygenation

The administration of a concentration of oxygen is of such benefit in the management of cardiovascular emergencies, drug reactions,

syncope, shock and other conditions that may confront the dentist that adequate oxygen apparatus is now considered essential equipment in the dental operating room. In many instances of obstruction, oxygenation may be the only treatment required of the dentist. When a small foreign body, such as a tooth, is lodged in the larynx or aspirated past the cords into the lower airway, respiration may be labored and wheezing, and coughing may continue, but the obstruction obviously is incomplete. If the patient's consciousness is maintained and a normal color is essentially restored by the administration of oxygen, the dentist is justified in seeking the aid of those better equipped and qualified to care for the patient.

When obstruction is complete, as evidenced by blocked respiration and marked cyanosis, attempts at oxygenation are useless and time-wasting, and the administration of a gas under positive pressure may only serve to further impact the obstructing object.

Removal of Foreign Body from Airway

As soon as the patient is unresisting, either from voluntary cooperation, restraints, or loss of consciousness, the dentist should examine the larynx and remove the obstructing foreign body whenever possible. Thus, an emergency kit containing instruments for elevating the base of the tongue and the epiglottis, illuminating the area, and grasping the foreign body must be maintained at hand. A laryngoscope with self-contained light and a Jackson "alligator" laryngeal forceps are the ideal instruments for the procedure.

The dental chair is elevated and reclined, and the head rest is dropped sharply so that the point of the patient's chin, the prominence of the thyroid cartilage and the suprasternal notch are essentially in a horizontal plane and in a straight line. The operator standing directly behind the chair can then obtain a direct view of the larynx after instrumentation.

The tip of the laryngoscope is passed to the base of the tongue and the mandible is elevated. Under visualization, the tip is then passed beneath the epiglottis. All supralaryngeal structures are then elevated, revealing the multiple folds and ventricles of the larynx. If the foreign body is visualized, the Jackson forceps is inserted and the obstruction removed (Fig. 2). The foreign body may not be visualized at all, or it may be difficult to grasp and remove. Throughout this period, the operator must be acutely aware of the passage of time, counting the seconds to himself if a wall clock is not available. However, there is no specific time limit in which he may continue to work safely. The progressive steps in the procedure should each be accomplished

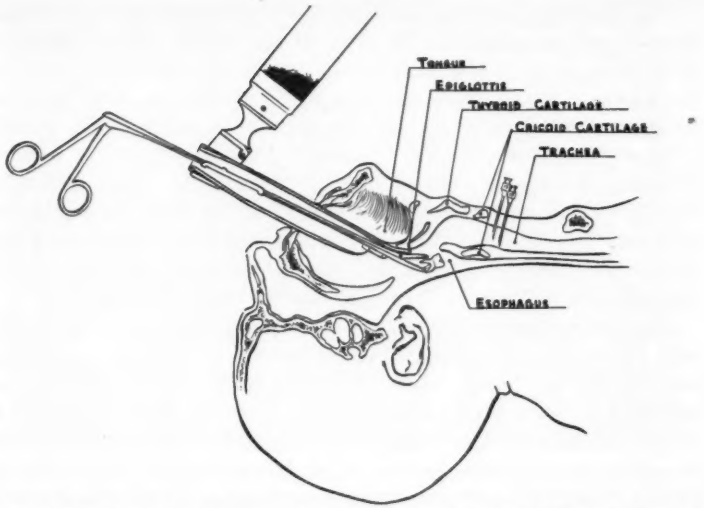

Fig. 2. Head position for removal of supralaryngeal foreign body with laryngoscope and Jackson forceps. Hypodermic needles (13 gauge) inserted into trachea.

readily. If complications develop, the operator has no right to assume that later efforts will be more successful. He must abandon the attempt at removal and establish a secondary airway.

Establishment of Secondary Airway

In the case of a small solid, such as a tooth, aspirated past the vocal cords, the obstruction is probably incomplete. A secondary airway is of no benefit in removing the object and should not be necessary as an emergency procedure.

In the case of liquids, treatment is best accomplished by direct suctioning after endotracheal intubation. Unless the dentist is trained in general anesthesia, however, he is probably not equipped or qualified for this procedure. If not, and if the fluid is not eliminated by coughing and the signs of asphyxia begin, a secondary airway should be established, a catheter should be inserted through the tracheostomy, and the fluid should be removed by suctioning.

In the case of complete obstruction above the trachea, a secondary airway may be immediately lifesaving. However, this does not imply that the dentist should accomplish a tracheostomy first and an examination second. As in the case of the beefsteak, it may be much quicker and easier to remove the obstructing foreign body than to open the trachea.

The secondary airway need not be established by the standard tracheotomy procedure in all cases. If the patient's lower airway is clear, if cyanosis is not marked, and if the operator has visualized the foreign body and believes he can successfully remove it, time can be gained by inserting several hypodermic needles into the trachea (Fig. 2); 13 gauge needles, 1½ inches long, are ideal. The cannula is large and three or four needles will provide an airway for a time. The length is sufficient for entering the trachea but not sufficient for inadvertent penetration through the posterior wall if the operator is reasonably careful. Eventually, the needles become inadequate through accumulation of bronchial and tracheal fluids.

Emergency Tracheotomy. The dentist must maintain a familiarity with the various procedures for establishing an emergency opening into the airway below the larynx. The emergency tracheotomy as described in most texts of surgery, oral surgery and laryngology is the procedure usually recommended. An incision through the readily accessible cricothyroid membrane just below the prominent thyroid cartilage may produce some permanent damage to structures of the larynx but few would criticize the dentist in an emergency who elected this procedure over the more difficult tracheotomy. I have had no opportunity to observe the Shelden tracheotome but Crue[4] gives an interesting description of the use of this instrument, developed on the trocar principle for a relatively safe entrance into the trachea. If such techniques are not clear to the dentist after study, he will find that he will be welcomed as an observer when the procedures are scheduled at any accredited teaching hospital.

Even so, such procedures may seem formidable to the inexperienced practitioner and he may hesitate until it is too late, while continuing fruitless efforts to remove the obstruction. He must remember that it is virtually impossible for him to cause secondary damage to tissue that is as serious as the suffocating patient's immediate need for air. If the patient is in the chair position previously described, neck extended and in a straight line, most of the pitfalls in the tracheotomy procedure are minimized.

After the tracheostomy is established, the lower airway should be suctioned free of fluids, then oxygen should be administered. If the secondary airway functions well, the emergency is over and the dentist may seek the aid of those qualified to provide further care for the patient.

Assuming that oxygen equipment, suctioning apparatus, and such minor surgical instruments as a scalpel and hemostats are standard equipment in the dental operating room, Figure 3 illustrates other equipment most suited for management of foreign body obstruction.

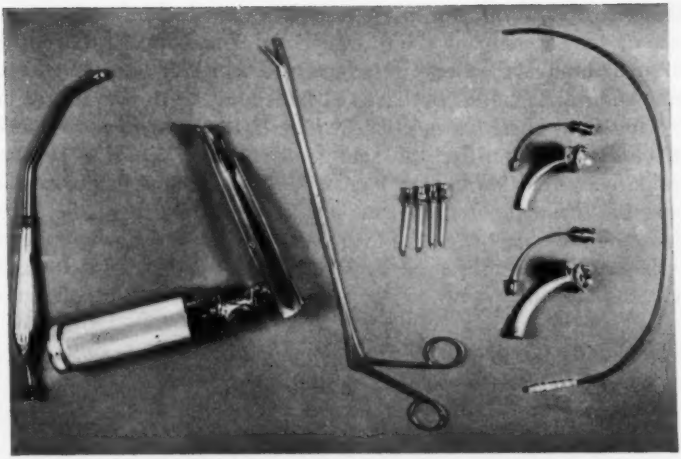

Fig. 3. Accessory equipment best suited for management of upper airway obstruction. Left to right: laryngeal suctioning cannula, laryngoscope, Jackson laryngeal foreign body forceps, 13 gauge hypodermic needles, No. 3 and No. 5 tracheotomy tubes, plastic catheter.

If the emergency comes, it is an extreme one and substitute equipment may be inadequate.

NON-OBSTRUCTIVE FOREIGN BODIES

Forbus[5] generally defines a foreign body as any material introduced into the tissue by routes other than the circulation, and he specifically defines it as any particulate substance occupying tissue space to which it does not belong and which serves no useful function. Using that definition, we need not consider in this limited article the many chemical and physical bodies purposely introduced, sometimes at a calculated risk, to perform some therapeutic function. The management of displaced tooth fragments is best considered in a discussion of mishaps in exodontia and the problem of sialoliths is best studied in connection with anomalies of salivary glands. With the subject thus narrowed, the primary considerations here are the nature of tissue reaction to exogenous substances, the mechanics of location and removal, and, as a matter of major interest, the dentist's responsibility in management of foreign bodies inadvertently introduced by himself.

Tissue Reaction

Although variations may be innumerable, the usual tissue response to a foreign body is a series of events beginning with an acute inflam-

mation attributed directly to the traumatic introduction of the object. Bacteria may accompany the foreign body or may secondarily invade the area through the same introductory channel. If so, the acute inflammation is enhanced by bacterial infection, but this no longer has the same clinical significance it had prior to the development of modern chemotherapy. After the acute inflammation subsides, the true foreign body reaction begins. Phagocytic wandering cells accumulate about the mass, proliferating and ramifying into all available space, separating the object from the living tissue by a layer of macrophages. If phagocytosis is prevented by the chemical nature of the foreign body, the cells may grow to giant size, fusing with other cells in an attempt to isolate and destroy the object. If unsuccessful, the cells may die and be replaced by others, creating dead tissue as a support for bacterial growth and chronic suppuration. If the foreign body persists, a second defensive mechanism begins. Fibroblasts proliferate and attempt to isolate the mass by concentric bands of hyalin connective tissue. Calcium salts and iron in the body fluids may be precipitated as a result of the changed hydrogen ion concentration in the area, encrusting the foreign body in layers of mineral salts, or converting an organic object into a chalky or stony mass.

Thus, if a foreign body resists phagocytosis, the result may be injurious in two ways: (1) Wandering cells may carry partly digested foreign material into the regional lymph nodes or into the general circulation, producing a general reaction if the material is soluble and toxic. (2) Locally, a bulky fibrous lesion may form, disturbing the normal structure and function of the part.

Usually, the production of a granulomatous lesion is slow, but the process may be so rapid on occasion that it resembles true neoplasia. On the other hand, if the reaction occurs in bone, the stimulation of osteoclastic elements may outweigh other factors so that the result is largely a destruction of tissue rather than a proliferation. Examples of these extremes are presented.

A 9 year old girl came to the clinic because of a rapidly growing gingival lesion which covered two of the lower incisors (Fig. 4). The lesion had first been noted 8 months before and had been excised twice, the latest attempted excision being but 8 weeks before. The lesion was firm, non-suppurative and non-tender. A clinical diagnosis of peripheral giant cell fibroma was made. The lesion was excised widely and deeply, including the periosteal layer. This deep excision disclosed a calcified mass in the base of the lesion, apparently formed by concentric deposits about a small piece of wax crayon. The bulk of the mass consisted of compact fibrous tissue, inflammatory elements

and giant cells. A diagnosis of granulomatous reaction to a foreign body was returned.

A 26 year old man was routinely examined in the dental clinic. The roentgenograms disclosed a large radiolucent area in the mandibular molar area (Fig. 5). The first molar had a large amalgam restoration and was non-vital to electric and ice tests. The third molar had been extracted three years before. The clinical diagnosis was odontogenic cyst, either radicular and secondary to the non-vital first molar, or follicular and residual to the previously removed third molar. The first and second molars were extracted, the interseptal bone was re-

Fig. 4.

Fig. 5.

Fig. 4. Reactive hyperplastic lesion of gingiva, secondary to a foreign body.
Fig. 5. Reactive osteolytic lesion of mandible, secondary to a foreign body.

moved, and the radiolucent area was entered. Considerable brown fluid was removed but no cystic membrane was noted. It was then thought that the lesion was probably a hemorrhagic or traumatic cyst but, on further examination, a small object was observed in the bottom of the cavity. This was removed and sectioned, disclosing concentric calcified rings about a clearly identifiable section of peanut shell, apparently introduced into the third molar socket three years earlier.

Location and Removal

Foreign bodies can be grouped for purposes of removal into those that can be located by roentgenograms and those that can not. If a roentgenographic examination is negative, the operator may locate a foreign body by probing, digital examination, or careful visual search. If the object is not superficial, these latter methods may be ineffective

unless the suspected area is surgically exposed. The electromagnetic locator is useful in certain body areas but I have had no personal success with this instrument about the mouth. However, with minor modifications and with an experienced operator, the locator should also be a valuable tool.

The operator's suspicion must be aroused in the absence of a history of the introduction of a foreign body, else he may treat reactive lesions over extended periods without suspecting a foreign body as the cause. Along with neoplasia, the dentist should consider a foreign body reaction in the differential diagnosis of any chronic lesion, particularly in the non-odontogenic lesions which present a fistula, a suppurative discharge, or a fibrous or granulomatous enlargement.

Most metallic foreign bodies are relatively inert and non-toxic, and the exceptions, such as lead, are usually not the dentist's problem. Hence, the mere diagnosis of a metallic foreign body is not a cause for concern unless a harmful reaction is clinically evident. One area in which otherwise innocuous objects may produce symptoms is the masticatory muscle area. Here, the imbalance of forces between muscles opening and closing the jaws may result in trismus even if the tissue reaction is minor. The broken hypodermic needle in or near the internal pterygoid muscle is the major problem of interest in this area.

Thoma[6] describes the generally approved method of location and removal. A second needle is inserted into the approximate area of the broken needle and fixed in position. The relationship of the two needles is then established by roentgenograms. Using the projecting locator needle as a guide, an incision is made through the mucosa at the estimated mid-point of the broken needle and at right angles to it. The deep tissues are then carefully separated by blunt instruments to avoid injury to vessels and nerves. The projecting locator needle should not be difficult to locate, which in turn permits location of the broken needle. Thoma employed the Kazanjian locator in the reported case. This device consists of a tube soldered to an Angle band and anchored to a molar tooth so that the tube points generally toward the broken needle. The locator needle is then inserted through the tube into the tissue adjacent to the broken needle. Figure 6 shows a modification of this device which is made of a tube anchored in quick-curing methyl methacrylate, a useful device when molar teeth are not present. The construction of such preparatory devices is not time-wasting but is essential to an orderly removal of a small foreign body from this area with minimal trauma.

At least two, and preferably three, roentgenograms made at right angles to each other are necessary for establishing the position of the

broken needle in relationship to the fixed locator needle. Figure 7 shows the anteroposterior view of a prepared model, indicating that the point of the locator needle is centered on the broken needle. Yet, Figure 8, the lateral oblique view, shows the broken needle slightly inferior to the locator and Figure 9, a vertical view, shows the broken

Fig. 6. Fig. 7.

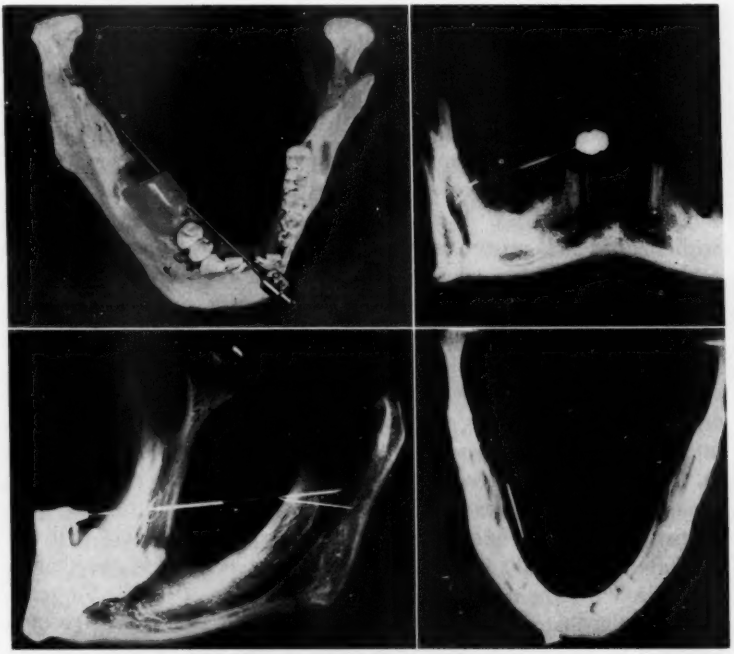

Fig. 8. Fig. 9.

Fig. 6. Modification of Kazanjian locator, constructed of methyl methacrylate.
Fig. 7. Anteroposterior roentgenogram of model. Locator needle bisects broken needle.
Fig. 8. Lateral oblique roentgenogram of model. Broken needle is inferior to locator needle.
Fig. 9. Vertical roentgenogram of model. Broken needle is lateral to locator needle.

needle lateral to the locator. Interpretation of the three views gives the operator a clear picture of the relationship, whereas one view alone would be misleading and relatively useless.

The removal of a foreign body from the anterior oral tissues is greatly facilitated by immobilizing both the object and the adjacent tissue. Palpable objects in the lips, cheeks or tongue can usually be

immobilized by locking the tissues between the arms of ringed-tip forceps, such as a gauze pad holder. Such instruments also permit inversion of the lips and cheeks for better surgical access if one arm of the forceps is passed extraorally and one arm intraorally over the palpated foreign body. Objects in the floor of the mouth can be immobilized by traction on sutures which have been purse-stringed about the area of the object.

Blast injuries and certain other accidents sometimes cause superficial impregnation of tissues with countless small particles of dirt, metallic fragments, and other debris. The tissues may close over these particles, producing a disfiguring tattoo. The operator who treats such injuries in the first few hours may largely prevent disfiguration by thoroughly cleansing the area with a surgical detergent. This type of débridement may require a general anesthetic in extensive maxillofacial injuries. Particles not removed by scrubbing can be picked out with small dental instruments such as periodontal curets. The earlier such débridement is rendered after injury, the better the result.

The Dentist's Responsibility

Archer[1] presents a concise discussion of some of the legal aspects of oral surgery, including the breakage of needles. The dentist is not usually held liable unless some injury is shown and the injury must be the direct result of negligence. However, there are exceptions. A New Jersey court allowed a jury to decide between plaintiff and dentist as to the manner of breakage, thus ruling in effect that the breakage of a needle itself constituted negligence unless the dentist could show that he used every precaution to prevent it. The Supreme Court of the State of Washington held that the mere breakage of a needle was evidence of negligence, stating that such a result seemed unnecessary and indicated lack of care. Courts have held that the failure to take reasonable steps to discover and remove a broken needle is negligence, as is the failure to inform the patient of such an accident.

If the dentist believes that he has not been negligent and informs the patient of the details of the accident at the first opportunity, the legal aspects of the problem are not then usually sufficient to justify a difficult surgical removal of a relatively inert foreign body. Why, then, should it be removed? Archer[2] states that all broken needles should be removed for the patient's peace of mind, citing the tendency of the general public to believe that such objects may be the cause of grave injury.

In my opinion, the peace of mind of the dentist himself is an equally

important argument. Of course, dentistry is firmly based on science, but the successful practice of it is still largely an art. The dentist's pride in his art is as important to the further advancement of the profession as is the continuing progress of science. If he inadvertently introduces a foreign body into tissue and fails to remove it, he has failed to complete his assigned task satisfactorily. If he believes he is unable to remove the object without undue trauma, he may fulfill his responsibility by discussing the problem with his patient and referring the matter to a qualified specialist.

The dentist's major responsibility in the management of foreign bodies is not one of removal, however, but one of prevention. Common preventive measures are thoroughly discussed in the standard texts. These include use of sharp and new instruments, approved impression materials, rubber dams and throat packs, suture of extraction sockets, study of postoperative roentgenograms, and many other measures. The adequate teaching of technical procedures at all levels of training is also of major importance. This is well illustrated by comparing the rarity of broken hypodermic needles in recent years to the frequency of this accident a few decades ago. Blum[3] reported in 1928 an analysis of 100 incidents observed in a relatively short period. Steel needles accounted for 96 of the 100, so the declining popularity of iridioplatinum needles does not explain the recent rarity of the accident. Of course, the manufacturers have greatly improved the steel needle in recent years. However, 82 of Blum's observed incidents followed injections for conductive anesthesia of the inferior dental nerve. During the period of his observations, the majority of dentists then in practice had not received intensive undergraduate instruction in conductive anesthesia. Surely, the thorough teaching of the approved technique for this injection in recent years must be largely credited for the infrequency of this once common accident. Similar results might be obtained from similar intensive teaching of other technical procedures.

In teaching oral surgery to dental interns, I have concluded that the two major causes of accidents, whether the introduction of foreign bodies or other problems, are the inexperienced operator's failure to obtain his patient's cooperation, and failure to attain the access and visibility required for the operation. Before attempting any technical procedure, the operator might first direct his thoughts along the following line: "I am going to attempt to do such and such. This patient must help me if he can. At least, he must not interfere. I must have access to the involved area and I must see what I am doing." By methodically directing his knowledge and his physical aids to attaining these preliminary requirements, he simplifies his task and reduces the possibility of an accident to a minimum.

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The Cardiac Patient as a Risk in Oral Surgery Practice

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Only on rare occasions should a cardiac patient be deprived of necessary oral surgery if skillful personnel and adequate facilities are available. The fact that surgery and anesthesia increase stress is well established, but either or both of these are extremely flexible and can be adapted to the requirements of the patient. Cardiac disease should not carry with it the burden of causing an individual to suffer from an otherwise correctable condition.

Mortality Rates

Accurate statistical data on deaths due to anesthesia and surgery are not available except from individual groups. The type of cases included makes comparison unjustifiable. These vary from the extremely high rate of 1 in 2680 reported by Beecher and Todd,[1] to the amazing more than 200,000 consecutive cases without a fatality reported by William T. Ewing.[3] The cause of death is frequently obscure but anoxia probably receives and merits the most prominent listing. It is noteworthy that in modern hospitals known cardiac patients usually tolerate anesthesia and surgery extremely well. Except for the ones on whom cardiac surgery is being performed, death on the operating room table is indeed rare. This is undoubtedly due, in a large measure, to the additional attention and precautions expended when a poor risk is involved. Properly prepared patients, anesthetized by capable and vigilant anesthetists, should survive all intelligently planned operations. Although this goal is high, we believe that it is attainable in all but the rarest instances.

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GENERAL CONSIDERATIONS

Cogency of Operation

Before any decision is made as to advisability of surgical intervention, careful and intelligent appraisal of the necessity for the procedure must be balanced against the cardiac disability to determine whether or not the risk warrants the operation. Usually the dentist is capable of making this decision himself, but in the more seriously ill patients with questionable cardiac reserve, he is obliged to seek counsel from qualified cardiologists and anesthesiologists.

Variables

Categorical statements as to operability are impossible since so many diversified factors are involved in this decision. Each patient presents an individual surgical problem, cardiac disturbance and anesthetic risk. For example, an extraction might be difficult or simple; a patient with rheumatic heart disease may have little or complete incapacity; anesthetization may be perplexing or easy. The complexity of the situation is increased when we include the capabilities of the persons involved. Although a chain is only as strong as its weakest link, we are sure that the cardiac strain can be lessened by stronger links. If the facilities and equipment are inadequate, the surgeon inept and the anesthetist incapable, even a robust patient might have difficulty surviving the simplest extraction. On the other hand, it is shown daily that even the poorest risks tolerate major procedures when capable personnel and proper facilities are available. Just as a poor carpenter needs a lot of tools, a poor surgeon needs a lot of instruments and a good anesthetist; a poor anesthetist needs a lot of equipment and good consultations; a poor risk patient needs a lot of expert care.

It is regrettable that many patients believe they are unable to survive any type of operation or anesthesia. This erroneous concept frequently stems from a well-meaning family physician, unqualified because of inexperience to make such a decision. More often it emanates from the misinterpretation of the physician's statement or following an unpleasant experience during a previous operation. We would be foolhardy to accept every patient's own evaluation of his "heart trouble" but we would be stupid if we did not carefully elicit a history of his disability and compare it with the physical findings. Where adequate facilities are available a team consisting of an oral surgeon,

an anesthesiologist and a cardiologist should make the term "too poor a risk" practically obsolete.

OPERATIVE RISK

In attempting to predict the outcome of any operative procedure we are obliged to consider, in the order of their importance: the patient, the nature of the operation, the skill of the surgeon, the ability of the anesthetist, and the availability of proper consultants and facilities. Under conditions other than ideal the above order might require rearrangement. The patient is the all-important factor and we are dedicated to his welfare. We have no right to subject him to unnecessary risks and we are obligated to know when to seek better qualified and warranted consultation. The oral surgeon must evaluate not only the patient's cardiac reserve but also his mental attitude.

Cardiac Reserve

Invaluable aid comes from obtaining an adequate history relating to the patient's cardiac disability. For reasons not always understood, patients may exaggerate, hide or minimize their symptoms, and this tendency makes eliciting a true picture extremely difficult. A satisfactory history must obtain information concerning the patient's exercise tolerance. Francis C. Wood[6] very properly stresses this point. Do not let your judgment be clouded by unimportant electrocardiographic anomalies, minor blood pressure elevations, insignificant arrhythmias, or auscultatory findings of doubtful significance. The important thing to know is, Does he get short of breath or have anginal pain when he exercises? More can be learned concerning the patient's cardiac reserve by a careful, intelligent history and physical examination than by all the elaborate tests available. Certainly these studies are of great value to the cardiologist who requests them as indicated, but they should only be employed when they can be properly evaluated. A glaring abuse of laboratory tests is the electrocardiographic tracing requested by a physician unqualified to interpret the findings. In most hospitals these are read by people who have not seen the patient and have an inadequate history. The result is that they are termed "normal," "borderline normal," "possibly significant," etc. Too many physicians and dentists have the mistaken impression that if the electrocardiographic test is normal or only slightly abnormal the heart is functioning satisfactorily. Never be deceived by such a false concept, because there are hearts in which conduction is normal in spite of poor reserve.

As a rule of thumb, patients giving a history of dyspnea, or orthopnea, chest pain, edema of the ankles, easy fatigability or cough require the advantages of more astute scrutiny. These are frequently signs of cardiac failure and should alert us to the fact that this patient has poor reserve. Stress caused by relatively minor trauma or hypoxia might produce a distressingly rapid and fatal result. Cardiacs must be properly prepared for operation and it is essential that elective procedures be carried out only when optimal cardiac compensation has been achieved and other acute or temporary conditions such as infection, anemia, or pregnancy are not adding to the strain on the damaged heart.

Congenital abnormalities and rheumatic, coronary, hypertensive or syphilitic heart diseases most commonly confront us. These hearts are usually enlarged and coronary circulation is frequently impaired. Anything that would lead to incomplete oxygenation of the blood or that would impair its circulation must be avoided. This requires planning and foresight in order that a coordinated effort will be productive of a gratifying result. Emergencies may demand short cuts but one must never lose sight of the constant need for adequate oxygen and adequate circulation during even the simplest procedure.

Precautions

Perhaps a safe premise to presume is that the seriously ill cardiac patient is just barely able to survive. Our efforts must be aimed at avoiding anything that will increase the work of the diseased myocardium or decrease its oxygenation. Apprehension, pain, fever, shock, blood loss, hypoxia, carbon dioxide excess and acidosis put additional strain on the failing heart that might throw it into decompensation, which further interferes with circulation and myocardial oxygenation. This muscle endures an oxygen deficit much less satisfactorily than skeletal muscle and ceases to function with a debt of about one-fifth as great as that of skeletal muscle.[2] The myocardium is also highly sensitive to changes in *p*H and, as a consequence, when lactic acid in heart muscle increases or the *p*H falls, extra systoles, heart block or other irregularities occur, followed by cessation of beat. The hypoxic heart muscle is also much more prone to atopic foci of contraction and to fatal ventricular fibrillation or asystole. The more potent inhalation anesthetics also increase the irritability of this muscle. We are most frequently confronted with a catastrophe when the factors of a diseased heart, hypoxia, carbon dioxide excess, change in *p*H and irritating drugs play in concert.

Our prime purpose, therefore, must be to prohibit any oxygen or

circulatory debt and if possible create a positive balance. Methods for accomplishing this include providing supportive treatment of preexisting heart and lung pathology to make those organs maximally effective, reducing metabolic requirements, increasing oxygen supply and enhancing circulation. Occasionally the positive balance is not obtainable, but oxygen debt cannot be tolerated for even short periods.

Fear, pain and apprehension must be allayed, as the effect of endogenous epinephrine is just as detrimental as its exogenous administration. There is considerable clinical and experimental evidence that many of the cardiac irregularities occurring during the induction of inhalation anesthetics are due in a major degree to excessive secretion of epinephrine. Dibenamine preoperatively is effective in eliminating some of these arrhythmias.[5] Pentothal sodium, which allows for a rapid, smooth and quiet induction, has been demonstrated to reduce markedly the cardiac arrhythmias of ether and cyclopropane.

Position

The position of the patient is an important but often ignored detail. After sedation or anesthesia and during the operation the normally orthopneic patient is too frequently placed in a supine position which interferes with adequate oxygenation. These patients should be maintained in a position similar to the one they assume during natural sleep. Sitting upright in a dental chair after sedation or during anesthesia may cause profound hypotension. If this position is deemed necessary, firm wrapping of extremities with elastic bandage will aid considerably in preventing a fall in blood pressure.

Shock and Trauma

Many patients with decompensated hearts are hypervolemic and polycythemic. The former condition makes them more prone to pulmonary edema and the latter to thrombosis or thromboembolism, which are frequent complications of major surgery that terminates unsatisfactorily. Shock, due to blood loss or extensive trauma, slows the circulation and not only increases the incidence of thrombosis but also interferes with the function of all body tissues by the resultant stagnant anoxia.

The decision as to how much surgery should be done at each sitting must be individualized in order to avoid stress from fear, pain, trauma or blood loss. Fortunately, the trauma and blood loss, in the more common operations, are relatively small and as a rule transfusions are not necessary. Cardiac patients do not tolerate excessive amounts of in-

travenous fluids. It is better to avoid salt administration entirely and err on the side of under-replacement of blood, rather than overtransfusing them into pulmonary edema.

Under local anesthesia there is probably adequate reason for performing multiple short procedures. However, under well established general anesthesia one should be guided by the progress of the operation and the patient's response to the insult rather than by a prearranged decision to remove one or two teeth at a time. Here, again, only experienced judgment of the specific problems involved will produce the ideal results.

Infection

Preoperative or postoperative infection increases oxygen consumption, and every effort must be made to treat or prevent it. Patients with valvular disease must also be protected from bacterial endocarditis, which threatens them following any oral surgical procedure. Prophylaxis should consist of at least 500,000 units of penicillin daily beginning on the day before operation and continuing for a minimum of 3 days postoperatively. When any acute infection exists, sensitivity studies must be carried out and appropriate antibiotics administered.

ANESTHETIC MANAGEMENT

When the operation and the patient are amenable to local anesthesia, it is certainly the safest method. However, if the patient is apprehensive and the operation painful, a well administered general anesthetic or possibly a combination of general and local anesthesia is probably more satisfactory. Fortunately, we are beyond the era of a choice of either regional or nitrous oxide anesthesia. With the discovery of new drugs and techniques utilized by anesthesiologists, properly trained dentists and technicians we can now offer oral surgical patients the same type of expert care that is given patients undergoing heart surgery.

Local Anesthesia

If local infiltration or block is selected the drug employed is of little consequence. Most of us have favorites that work best in our experience and this adds to our self-confidence. Epinephrine probably should not be used, owing to its excitatory action on the heart. When it is added to the local anesthetic solution a concentration of 1:100,000 is adequate. Limits of volume and concentration are dictated by the

specific potency and toxicity of the drug. Administration of a barbiturate (phenobarbital gr. 1 to grs. 1½) one hour beforehand reduces cortical irritability and is advisable in apprehensive patients or when large doses are employed. This does not preclude an unfavorable reaction to the drug. Syncope following even minute amounts must be anticipated and treated by placing the patient in the Trendelenburg position and administering oxygen and intravenous barbiturates if necessary.

Unfavorable reactions to local anesthetic agents are more often explainable on a basis of emotional stress than by a physiologic disturbance due to the anesthetic drug itself. Prevention is attempted by reassurance beforehand and explanation of the manipulation that will follow.

A history of inability to "take Novocain or freezing" is frequently procured and one is obliged to get specific detail before deciding upon the use or abandonment of this technique. Methods for testing sensitivity leave much to be desired and we are more dependent upon an accurate history than any scientific method. Reliable knowledge of the specific drug previously employed is usually unavailable. Even though drugs totally unrelated chemically are now available, sound judgment dictates that local anesthesia be avoided if a bona fide reaction has occurred.

Combined Local and General Anesthesia

Many simple and meritorious techniques have been advocated to combine local and general anesthesia in order to avail oneself of the benefits of both methods.[4] Perhaps there are frequent instances where this may be advisable, but as a general rule we feel that cardiac patients do not lend themselves to this combination. Oral surgical patients do not require profound and depressing planes of anesthesia and it is usually not the drug given that produces the complications but the events that follow induction (excitement, respiratory obstruction) that set the stage for disaster. We feel that the anesthetist who is capable and prepared to meet all of the surgeon's requirements with only general anesthesia will find himself in better control of all eventualities.

General Anesthesia

Preparation. The cardiologist can best accomplish his responsibility when given the opportunity to make necessary examinations, studies and observations that will determine when the patient is ready for

operation. Frequently this will require several days of therapy consisting of digitalis, diuretics, aminophylline and bed rest. When patients have been treated adequately by their family physician the only requirement may be that they continue with their usual therapy. Abnormal rhythm of the pulse frequently causes undue concern and does not, as a rule, require specific therapy.

Mental tranquility as well as physical rest is desirable and is secured by kind reassurance aided by mild sedation. Immediate preoperative drugs should be individually selected, and great care must be taken to avoid large doses of narcotics or barbiturates which may depress the blood pressure as well as respiration. Error on the side of too little is advisable, since the dosage can be supplemented if necessary. In the moderate risk patient of average build, we employ a barbiturate such as pentobarbital 50 to 100 mg. by mouth 90 minutes before scheduled operation, and Demerol 50 to 75 mg. hypodermically ½ hour after the barbiturate. In the more seriously ill patients we employ the smaller dose of pentobarbital and frequently omit the Demerol. The judicious employment of scopolamine or atropine 0.3 mg. 1 hour before anesthesia usually prevents excessive salivation which might interfere with the gases, anesthetic as well as oxygen, being carried into the alveoli and across the alveolar membrane. Atropine is believed also to have the desirable effect of obtunding vagal reflexes. Tachycardia, rarely produced by this drug, is not a contraindication to its use.

Properly administered general anesthetics should be safe in all but the very exceptional severely incapacitated cardiac patient. The mild cardiac who is able to go about with routine daily activity presents no special problems and can be handled as any other patient. As the disability increases, so must the preparation and skill of the participants. The surgeon's responsibility to determine how much he can handle himself weighs heavily on him. Where there is any doubt he must seek available assistance.

SELECTION OF ANESTHETIC AGENT

Choice of the anesthetic depends on many factors, and perhaps the least important is the agent itself. Some years ago it was fashionable to specify a certain drug as best for a particular operation. We now employ so many anesthetics in different combinations that none can be said to be the best or, on the other hand, absolutely contraindicated. The anesthetist should always be allowed to choose the agents and techniques with which he is most proficient and which will

not unduly interfere with the surgeon's approach to the operative field. Employment of the nasal or oral endotracheal tube has done much to insure an unobstructed airway through which oxygen and anesthetic gases may be continuously supplied.

Many unfortunate patients have suffered and many oral surgeons and anesthetists have been needlessly aggravated by a note from a family physician stating that the patient must or must not have a specific anesthetic agent because of the presence of some physical disorder. Such notes, as a rule, are unnecessary and they only serve to reveal the family doctor's ignorance concerning anesthesia. The person giving the anesthetic should know of any abnormality in his patient and then decide what is best for him. It would be far better for the family doctor to choose the anesthetist than to select or eliminate an agent. As has been repeated so frequently, it is the anesthetist and not the anesthetic agent that most frequently is responsible for good or bad results.

The anesthetist, like the surgeon, must know his own limitations and not risk the patient's well-being. The agent he uses most frequently and best is the one he should employ. Relative advantages of one drug over another are far out-weighed by the disadvantages imposed on the anesthetist who is endeavoring to use a drug whose effects and responses are unfamiliar and poorly interpreted.

All too frequently do we get letters with messages such as, "Do not use Pentothal anesthesia because this patient is hypertensive," or "Do not use gas because this patient has asthma," or "Use local because this patient is hyperthyroid." These are just a few examples of the conscientious doctor trying to help his patient. You can see at a glance that they are of no real value. Certainly, Pentothal sodium alone may be a poor agent with which to produce profound anesthesia in a hypertensive patient, but it might be the ideal induction or basal anesthetic agent. The asthmatic patient might do very well with nitrous oxide and vinethene or ether, but the physician prohibits it. On the other hand, nitrous oxide without supplementation might be a poor agent in the muscular emphysematous asthmatic. Finally, the hyperthyroid patient should do much better if relieved of the anxiety of local anesthesia. Nitrous oxide and oxygen alone might be poor, but who could find fault with Pentothal and nitrous oxide for these patients?

A pharmacologic dissertation on the merits of the drugs commonly used is not the purpose of this paper; however, there are so many false notions about some of them that clarification seems justified concerning Pentothal sodium, nitrous oxide and cyclopropane.

Pentothal Sodium

Pentothal sodium is a poor anesthetic agent since it produces little if any analgesia. Given intravenously or rectally it is an excellent basal anesthetic, but it should be supplemented with some anesthetic agent except in very brief procedures. This drug is a profound respiratory and cardiovascular depressant when given in large doses, and it should be employed only by trained personnel where resuscitative apparatus is immediately available. In small hypnotic amounts it very rapidly and pleasantly induces sleep with little depression and avoids the excitement and apprehension that is caused by a mask or nose piece. Pentothal is a parasympathomimetic drug and, therefore, increases the irritability of the pharynx and larynx.

Nitrous Oxide

Nitrous oxide would be an ideal anesthetic if it were more potent. If high concentrations are required that limit the amount of oxygen, it should be supplemented by a drug such as Pentothal sodium, ether or vinethene. Rapid induction and recovery, and practically no change in organic function are its greatest assets. Anoxia is not an essential accompaniment to the use of nitrous oxide. Combined with drugs that produce analgesia or basal anesthesia, it is a safe and useful agent in even poor risk patients.

Cyclopropane

Cyclopropane is a safe anesthetic. The fear of the arrhythmias it causes is grossly exaggerated. The light planes of anesthesia required for oral surgery are not usually productive of any alarming rhythm changes. Most anesthesiologists, properly trained in its use, employ cyclopropane as a drug of choice in cardiac patients regardless of the preoperative arrhythmia. Its range of explosibility is slightly less than that of ether.

SUMMARY

Patients with heart disease tolerate surgery and anesthesia well under ideal conditions. The abnormality itself is not as important in prognosis as is the tolerance to exercise. Patients who are able to carry on with the usual daily activities of an average person without developing dyspnea or angina are considered good risks. Cooperative efforts of an oral surgeon, an anesthesiologist and a cardiologist should make almost any cardiac patient suitable for operation. Oxygenation and

maintenance of circulation are imperative and can be accomplished when the available agents are employed judiciously.

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The Management of Pregnant Patients in Dental Practice

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It is routine practice for the obstetrician, in the course of the pregnant woman's first prenatal examination, to perform a dental examination. Usually, even in the absence of gross dental defects, the physician will recommend that his patient be seen by a dentist for more detailed examination and treatment. The modern obstetrician not only recommends prenatal dental treatment, but in fact insists very often that the correction of dental defects in the pregnant patient is actually more important than their correction in the non-pregnant state.[2,4,19] It is not uncommon, therefore, for the dentist to have occasion to treat pregnant patients for a variety of dental or periodontal defects.

While it is often felt that pregnancy is a natural process and therefore can be treated quite casually, it must be emphasized that in fact gestation is a very complex process and is always beset by numerous hazards.[19]

Since it is the responsibility of the dentist to care for the oral health of the pregnant patient, it is important that we familiarize ourselves with some of the changes which occur in the oral tissue of these patients. At the same time we should be cognizant of the inherent dangers that may be involved in such treatment. The hazard in dental treatment for the pregnant woman is not so much to the expectant mother as it is to the unborn child. It is, of course, always in order where there is any doubt about a specific procedure or its timing, to consult with the patient's obstetrician. He, after all, is responsible for and knows best the patient's general physical condition.

CARIES

In general, research in the field of caries is difficult. This is no less true when caries in the pregnant patient is studied. This is the reason why the implications of the old adage "a tooth for every child," have not been completely scientifically disproved in good controlled studies. The bulk of the evidence in the literature indicates, however, that this adage is not necessarily true, if proper precautions are taken.[17]

It is known that calcium is added to the fetus chiefly during the last trimester, and half of it in the last month. It can therefore readily be seen that any depletion of calcium and phosphorus in the mother should not be expected to have an effect on her teeth at least until nearly parturition, at which time the increased mineral requirements in the lactating mother would be encountered.[3,17]

Although demineralization of the alveolar process is possible, there is no evidence that calcium or phosphorus can be removed from erupted teeth during pregnancy.[3,4,15] And yet it has been seen that some women do suffer markedly from dental caries during pregnancy.[5] Actually it is known that many tissues in the pregnant woman are unusually engorged and hyperemic. This is no less true of the pulps of already carious teeth. The hyperemia of pregnancy increases the severity of toothache caused by carious teeth, and thereby increases the need for dental care. This has led to the erroneous belief that the teeth become decalcified and decay rapidly when a woman is pregnant.[2]

Present data indicate that pregnancy per se is not a cause of dental caries, although pregnancy under unhealthy and unsatisfactory nutritional conditions may be a predisposing cause or a conditioning factor leading to dental caries. Most evidence seems to indicate that no increase in dental caries activity is necessitated by pregnancy. The calcium salts are not abstracted from fully formed erupted teeth during pregnancy, the salivary *p*H of pregnant women is within normal range, and there is a normal increment of new cavities during pregnancy.[3,17]

FOCI OF INFECTION

The question of dental and oral pathosis acting as a focus of infection and the cause of metastatic or secondary lesions elsewhere in the body is one which has long been debated. Yet, clinical experience tends to substantiate this belief.[20] Although the so-called apical abscess is usually looked for in cases where oral foci of infection are suspected, periodontal disease may often be as important. Infected teeth and periodontal infection are indeed a menace, and may in fact be closely

related to some of the complications of pregnancy, including toxemia, pyelitis, abortion, hypertension, and phlebitis.[2,3,4,19]

In one study a large group of pregnant women were closely followed from the standpoint of the relationship of oral foci to some of the complications of pregnancy. It was found that the incidence of abortion, pyelitis and hypertension was significantly increased in the women from whom oral foci of infection were not removed. On the other hand, these complications were correspondingly reduced in those women from whom oral foci of infection were eliminated. In this study the foci of infection were determined roentgenographically, by periapical radiolucency.[3]

The early eradication of oral foci of infection is thought to be one of the important reasons for the reduction in the incidence of pyelitis of pregnancy as well as possible complications of the postnatal period. Conversely, failure to eliminate foci of infection increases the chances for any of the numerous complications of pregnancy.[3]

PERIODONTAL DISTURBANCES

The susceptibility to gingival disturbance during this period is marked. It is important to institute proper dietary regulation and thorough and regular mouth care to prevent oral disease, and to treat it if it occurs.[16] Usually conservative periodontal treatment and maintenance of good oral hygiene will suffice to keep the gingiva in a healthy condition. The patient must be taught good home care, and the importance and technique of interdental massage must be emphasized. Although most pregnant women usually get supplemental minerals and vitamins from their physicians, this aspect of treatment must not be overlooked. For example, the pregnant woman requires from 100 to 500 mg. of ascorbic acid daily, compared with 50 to 75 mg. per day for healthy non-pregnant women.[3]

The etiology of periodontal disease cannot be ascribed to any one factor. Apparently many concomitant factors combine to produce clinical signs and symptoms. This is why, with the hormonal changes occurring in every pregnant woman, only some women will develop gingivitis or other periodontal disturbance, while in others the periodontal condition will remain clinically unchanged. It is the cumulative or additive effect on already existing causes or defects which is important, and not the pregnancy per se. It is known, for example, that gingival changes in pregnancy occur most frequently in individuals with poor oral hygiene.[3]

The most commonly occurring periodontal changes are those involving the gingiva and producing the so-called pregnancy gingivitis

(Fig. 1). It has been estimated that the average incidence of gingival changes in pregnancy is about 50 per cent.[8] These changes occur not much later than the second month of pregnancy, and increase to reach a peak toward the end of pregnancy. There may be some improvement in the ninth month and after birth. Unless secondary infection occurs, pain is not characteristic.[8,10]

Fig. 1. Pregnancy gingivitis. There is generalized gingival enlargement and engorgement, especially interproximally.

Fig. 2. Histologic picture in pregnancy gingivitis. The stalk tissue is riddled with capillaries, with extravasation at upper pole. The investing epithelium (upper right) is hyperplastic.

Histologically there is an increase of connective tissue and epithelial cells. Of prime importance, however, is the pronounced proliferation of capillaries (Fig. 2). These changes, especially the increased capillary formation, account for the clinical picture of pregnancy gingivitis, which is characterized by the so-called raspberry red gums, which bleed readily at the slightest pressure or touch. The connective tissue

proliferation is reflected clinically in the generalized gingival enlargement, especially interdentally. The papillae are bulbous, occasionally simulating a discrete tumor-like mass.[8] These interdental areas in fact may continue to increase in size, thus producing the typical pregnancy tumor. Such a tumor is made up of the proliferated connective tissue, epithelial cells, and capillaries, and can be described as an angiofibromatous epulis (Figs. 3, 4, 5).

The pregnancy tumor usually appears between the third and fifth months and increases in size with the duration of gestation. It may regress somewhat and even disappear after term, but generally the lesion persists.[22] At times it may become very large, separate and loosen

Fig. 3.

Fig. 4.

Fig. 3. Pregnancy tumor which occurred interproximally between the upper central incisors.

Fig. 4. Large angiofibromatous epulis which occurred during pregnancy (pregnancy tumor). This tumor mass extended from the attached gingiva labially across several lower teeth to the attached gingiva lingually. The indentations made by the occlusion of the upper teeth can be seen.

teeth, cause bone to be resorbed, become easily traumatized, and bleed at the slightest provocation. Such tumors require complete removal.

The gingival tumors of pregnancy, when small, should be treated conservatively, by removing any local irritating factor such as calculus, trauma, etc., and instituting good home care. If the tumors continue to grow, become ulcerated, bleed excessively with minimal trauma or interfere with mastication, then they must be removed. The removal of such tumors should be en masse, and down to periosteum or periodontal membrane. Coagulating electrosurgical technique should be used on the base of the lesion to control bleeding and to help prevent recurrence. Infiltration of local anesthesia in these cases is useful, since the vasoconstrictor in the local anesthetic solution helps to control hemorrhage.

All tissue removed, needless to say, should be sent for microscopic

Fig. 5.

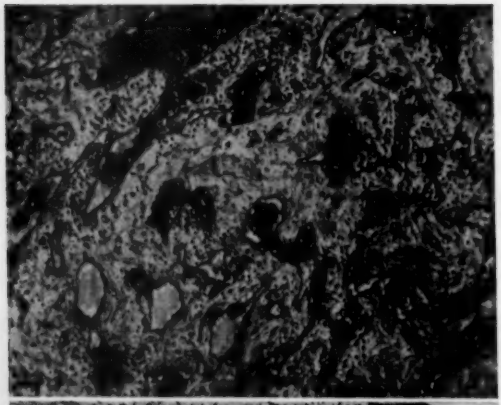

Fig. 6.

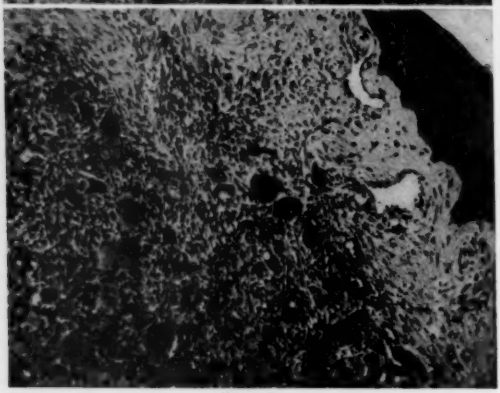

Fig. 5. Histologic section of tumor shown in Figure 4. Capillary channels convert the mass into a vascular sponge. Reactive inflammatory cells are scattered in the connective tissue stalk.

Fig. 6. Peripheral benign giant cell tumor, which occurred during pregnancy. The stalk tissue is rich in foreign body giant cells, some containing as many as 20 nuclei.

examination. Tumors such as those of the peripheral giant cell type may occur coincidentally with pregnancy and can easily be confused with the true pregnancy tumors (Fig. 6).

MUCOUS MEMBRANE AND TONGUE LESIONS

Occasionally oral herpetic lesions are seen during pregnancy. The exact relationship of these lesions to the pregnancy is unknown, and their appearance may be simply coincidental.

The authors have had occasion to see two cases of a tongue lesion, simulating geographic tongue, which made its first appearance during pregnancy. In both cases the patients had been taking multivitamins as prescribed by the obstetrician, and in both cases the lesions persisted, with some periods of remission, long after term. These tongue lesions are a source of concern to the patient, especially since the production of depapillated areas on the tongue causes in such cases a burning or painful sensation. Here again, as with the oral herpetic lesions, the exact relationship to pregnancy, if any, is not known.

STRESS AND PREGNANCY

In recent years it has become increasingly apparent that maternal stress in pregnancy is of prime importance as a cause of congenital or developmental defects of the offspring.[11,21] Stress in general, whether it be emotional (anxiety), physiologic (infectious or other forms of disease), or traumatic (injuries or accidents), produces definite bodily reaction. In the pregnant woman the duration, intensity, and timing of the stress are all important, and in some cases may be devastating to the fetus.

For a long time it was assumed that most congenital defects such as mongolism, cleft palate, cleft lip, and others, were determined by chance arrangements of genes and chromosomes. It is now felt that maternal disease and other critical stresses occurring at certain stages during pregnancy, especially during the first trimester, are responsible for a majority of congenital anomalies. In fact, these anomalies are thought to be late manifestations of intrauterine stresses at critical phases of prenatal development. It is now felt that many if not most anomalous children have survived a temporary intrauterine stress.[11]

Stress may be emotional, physiologic, or traumatic; it may be in the form of radiation, vitamin deficiency, or anoxia. In any case, however, the stressor agents influence adrenal cortical activity via the pituitary gland. The resulting stress is reflected in the quantity of circulating hydrocortisone, which is produced by the adrenal cortex. The initial response to stressor agents is usually manifest in the form of the "alarm reaction," when the adrenal cortex undergoes physiologic hypertrophy which results in increased secretion of hydrocortisone.[21]

In animal experiments on pregnant mice, cleft palates were produced in 87 of 100 mice whose mothers were treated with cortisone for a three day period corresponding to the time when the maxillae usually fuse. The animals in the control group were free of clefts.[21]

In another series, pregnant mice were kept in low pressure chambers corresponding to atmospheric pressures similar to those at altitudes of

25,000 to 30,000 feet, where the oxygen tension is markedly reduced. Thus, the experimental animals were subjected to stress in the form of oxygen deficiency. A regular pattern of congenital deformities was thus easily produced by critical stress induced at a specific stage of development. For example, cleft palate was produced by subjecting the pregnant mouse to this hypoxic stress on or about the fifteenth day of its pregnancy, when the two halves of the palate are known to fuse.[11]

In a retrospective study of 232 cases of cleft palate at the Hospital of Saint Barnabas, Rehabilitation Center, Newark, New Jersey, maternal case histories revealed a high incidence of physiologic, emotional or traumatic stress at the time when the maxillae in the developing embryo were expected to fuse. It was believed by the authors of that study that the catabolic effect of an abundance of hydrocortisone secreted by the adrenal cortex in response to stress was an important factor in the production of this congenital abnormality.[21]

This concept of the effect of stress on the child in utero is of great importance. It makes all the more apparent the need for treatment of dental defects in the pregnant woman. It should be quite obvious that stress in the form of infection, either periapical or periodontal, must be eliminated. The acute infection with elevation of temperature, pain and pus formation must by all means be avoided. These factors add up to a stressful situation emotionally and physiologically. It is conceivable that such a situation occurring at a critical time in fetal development, in a patient with a low frustration tolerance or possibly a genetic predisposition, may produce delayed but none the less devastating results in the offspring.

TIMING OF DENTAL TREATMENT

The best treatment for any untoward reaction is to prevent it from happening, rather than treat it after it has occurred. This is, of course, especially true in the pregnant patient, in whom all necessary dental treatment should preferably have been completed before she became pregnant. The partially erupted lower third molars covered with soft tissue flaps and prone to infection should have been removed; carious teeth and periodontal disease should have been cared for. Obviously, however, this ideal condition is rarely obtained in practice.

Most obstetricians now believe that infected teeth and other oral infections are a menace, and that pregnancy is no contraindication for the completion of any necessary dental work. Nor is dental treatment any longer considered to be a precipitating factor in abortion.[2,4,5]

It has been estimated that one in five pregnancies terminates in miscarriage, and that the great majority of these occur in the first 12

weeks of pregnancy, usually during the third month.[1,7] After this time, the fetus is apparently more firmly attached to the uterus, and the chance of miscarriage is markedly reduced. In a susceptible individual almost any stimulus or stress, emotional or physical, may be sufficient to induce miscarriage. If a woman presents with a severe toothache or an acute infection in the first trimester of pregnancy, it is undoubtedly true that the stress of this situation is one which must be eliminated by immediate treatment. In a situation of this type, the possible harm to mother and child by allowing the disease process to take a natural course is much greater than the stress of an operation to relieve the acute symptoms. An incision for drainage, the removal of a painful tooth if indicated, or palliative treatment if necessary, should be done despite the newness of the pregnancy. If emergency dental treatment must be done in the first three months of pregnancy, due regard must be given to minimizing the emotional stress by adequate anesthesia, sedation if necessary, limiting the length of each session, and the avoidance of hypoxia.

Generally, because of the hazard of stress-induced abortion in the predisposed individual or possible deleterious developmental effects on the embryo, only emergency treatment for the relief of pain should be done during the first trimester.[18] From the fourth to the seventh month is the best time for dental treatment. During this time there is less nausea and vomiting, miscarriages are unlikely, the patient feels better, and as a rule the pregnant patient may be treated as any other normal individual.[7] If concomitant disease such as diabetes or a cardiac defect is present, of course added precautions must be taken. These added precautions, however, would be necessary irrespective of the pregnancy. The bulk of necessary dental treatment should be done during the middle four month period, from the fourth to the seventh month of pregnancy. Common sense will dictate and determine just what "necessary" dental treatment consists of. It should be quite obvious that long traumatic procedures such as the removal of symptom-free embedded or impacted teeth, removal of a torus palatinus, full mouth rehabilitation, and other similar procedures, are best postponed until after the termination of pregnancy.

ANESTHESIA

Anoxia is the principle danger to the fetus. This is important especially in anesthesia, either local or general. The partial pressure of oxygen of the fetus corresponds to that at about 33,000 feet above sea level, a level of such low oxygen tension that husky adults would die in it in a few minutes.[6] The fetus in utero actually lives in an oxygen

environment corresponding to that atop Mt. Everest. The fetus manages to survive and develop with this low oxygen pressure because of certain adaptations. For example, there is a pronounced increase in fetal hemoglobin (about 20 per cent higher than that of an adult or older child). There is increased bone marrow activity and, in addition, fetal hemoglobin is a special kind and gives off oxygen more rapidly than does that of adults or older children. Despite these adaptations, the fetus exists in a continuous state of cyanosis.[6] If this meager oxygen supply is depressed even lower than usual, either by vagaries of uterine contractility, by placental separation or by marked hypoxia during anesthesia, the fetus cannot endure it for more than a few minutes. A short anoxic episode which may have only a transitory effect on the mother may cause irreparable damage to the child in utero. The cerebrum is one of the first structures injured by anoxia, and it seems logical to believe that sometimes the degree of intrauterine anoxia may not be quite sufficient to cause the death of the infant, but enough to inflict irreversible injury to the cerebrum.

In administering local anesthesia to pregnant women, untoward reactions must be assiduously avoided, and if they occur they must be treated without delay. For example, any patient who goes into shock or syncope following the injection of a local anesthetic is at that moment hypoxic. Care and caution must be used to avoid inadvertent intravenous injection of local anesthetic solution. The patient may react to the injection of a local anesthetic with partial cardiovascular collapse and central pooling of blood. The pulse becomes rapid, weak and thready, and sweating and pallor are noted. This state in the pregnant woman should not be allowed to persist. Oxygen should be available and must be administered immediately, together with the other procedures necessary in the treatment of syncope. It must be emphasized that although in the hands of many dentists local anesthesia is considered safer than general anesthesia, local anesthesia is still not without hazards, especially in the pregnant patient.

The administration of a general anesthetic during pregnancy does not introduce special hazards to the mother or the fetus, nor does it endanger the normal course of gestation, if maternal cardiovascular distress and anoxia are avoided throughout. The principal danger to the fetus is anoxia. When general anesthetics are carefully administered during a normal pregnancy there is little reason to anticipate harm to mother or fetus if the mother is adequately oxygenated throughout, and maternal cardiovascular distress is avoided.[9] In addition, it should be noted that pulmonary ventilation must at all times be adequate so that carbon dioxide is prevented from accumulating.

We, as dentists, cannot ignore in the pregnant patient the inherent

hazards of reflex effects resulting from emotional and physical stress. Emotional stress during local anesthesia can be abolished or reduced to a minimum with adequate premedication with a suitable hypnotic such as pentobarbital (Nembutal) or meperidine hydrochloride (Demerol). The choice of anesthetic should be determined by the patient's general condition and not by the fact that she is pregnant.[12] The dangers of anoxia, however, cannot be overemphasized.

It has been shown that barbiturate derivatives in moderate dosage may produce slight to severe anoxia due to respiratory and circulatory depression and reduction of cellular respiration.[14] Determinations of arterial blood oxygen were made in a series of patients undergoing orthopedic surgery.[13] All of these patients had been premedicated with from ¼ to ⅙ gr. morphine sulfate and $\frac{1}{150}$ gr. atropine sulfate, and all were induced with Pentothal sodium, 2½ per cent. The results are noteworthy. With the patient breathing room air and induction with Pentothal sodium (thiopental) the blood oxygen fell from 87 per cent saturated to as low as 68 per cent saturated. When a 50-50 mixture of nitrous oxide and oxygen was added, the blood oxygen level became 98 per cent saturated within 3 minutes.

In another case, induced similarly, oxygen was added and the blood oxygen level rose from 81 per cent to 100 per cent in 2 minutes. In still another case, the patient breathed oxygen for 5 minutes before induction with Pentothal. In this case the blood oxygen saturation was maintained throughout the procedure at a level of 98 to 100 per cent.

In view of the hypoxic effects of Pentothal sodium when used as the sole anesthetic, the advisability of employing this drug as the sole anesthetic agent in pregnancy is questionable.

Induction with Pentothal is extremely easy, calm, and pleasant for the patient. It should be used, however, for induction only, and the patient should be maintained with a 50-50 mixture of nitrous oxide and oxygen. At the termination of the operative procedure, 100 per cent oxygen should be administered until the patient is fully reacted.

Nitrous oxide and oxygen in a 50-50 ratio is as efficient as 100 per cent oxygen in maintaining high blood oxygen levels, and has the further advantage of reducing the Pentothal requirement.[13]

A good, safe, balanced anesthesia is one which will maintain at all times a well oxygenated patient free of pain and emotional stress. Such an anesthetic may be found in the combination of local anesthesia with nitrous oxide and oxygen analgesia. The uptake of nitrous oxide by the fetal brain is relatively slow. In addition, the nitrous oxide is rapidly excreted so that the fetal nervous system is not significantly depressed if anoxia is avoided throughout.[9]

Local anesthesia together with Pentothal sodium is also a very

rewarding combination. However, oxygen should be administered throughout the procedure.

The choice of anesthesia is one which is dependent on many factors, not the least of which is the operator's familiarity and knowledge of the specific anesthetic he chooses. The use of general anesthesia in a normal pregnant patient is in some cases necessary, and in no case is it contraindicated. The prime and foremost fact to remember is to avoid even mild degrees of anoxia for even the shortest period of time. Anoxia must not be allowed to occur in the pregnant woman. This applies equally to local and to general anesthesia. Every dentist who administers an anesthetic of any kind should have oxygen ready at hand with an apparatus to deliver the oxygen to the patient who needs it.

ROENTGENOGRAPHY

Roentgenographic examination of the teeth need not be postponed or delayed. The field of radiation in oral roentgenography is far enough away from the pelvic region so that, with normal precautions, this hazard is practically nil. In any case, it is wise to use fast x-ray film, so that time of exposure is reduced to an absolute minimum.

SUMMARY

1. It is imperative to avoid anoxic episodes in the mother.
2. The optimal time for dental treatment is within the fourth through the seventh months of pregnancy.
3. Only procedures necessary to relieve pain or discomfort, or of other emergency nature, should be undertaken in the first 3 months of pregnancy.
4. Long, complicated, elective procedures should be postponed until after the termination of pregnancy.
5. In the normal pregnant patient, dental roentgenography presents no special hazards.
6. Appointments or sittings should be short, preferably not to exceed about ½ hour.
7. Pain should be avoided.
8. Home care should be emphasized in the general maintenance of good oral hygiene.
9. Oxygen in an administrable form should be on hand at all times.

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The presence of the expectant mother in the dental chair gives us an opportunity to impress upon her the importance of the care of children's teeth as they grow older. We should enlighten the mother-

to-be concerning the benefits of water fluoridation, so that the citizen in utero gets 9 months of good dental prophylaxis.

The expectant mother should and must get proper dental care during pregnancy. It behooves us as dentists to see that this is accomplished.

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Management of Shock in the Dental Office

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Prior to World War II much confusion was encountered both in defining shock and in determining the major causes as well as in the treatment of the various forms of collapse following mental or physical trauma. An individual in the state of unconsciousness exhibits many of the findings encountered in the intermediate or late stages of circulatory collapse incident to debilitating disease, head injury, hemorrhage or severe trauma. States following mental trauma, such as the receipt of bad news, the sight of blood, the fearsome aspects of injury or the anticipation of surgical operation, and those incident to blows to the head, the epigastrium or the testicle as well as unexplained attacks of syncope have been included by the layman as well as the professional in discussions of shock. Such conditions of stress frequently bring about certain autonomic nervous system phenomena associated with faintness or actual syncope. These conditions should be differentiated from true states of circulatory collapse resulting from hemorrhage, trauma to massive muscle groups, major fractures or the terminal conditions before death due to disease.

In the practice of dentistry few will encounter shock following massive hemorrhage or major body trauma. In the face of mass casualties, however, all students in the medical specialties should review the causes and treatment of shock due to these conditions. In case of overwhelming numbers of casualties the familiarity of members of the dental profession with the processes of abnormal physiology and pathology qualifies them to be called upon to assist the physician in

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the treatment of shock, whether it be due to burns, hemorrhage, extensive trauma, fractures or combinations of these injuries.

This discussion is limited to those shock or shock-like conditions which may be encountered in the office of the practicing dentist. Varying degrees of collapse may be encountered, even before any type of treatment has been administered as well as during or following the initiation of dental treatment. It is recognized that many patients approach the environs of the dentist or physician with varying degrees of concern even to the extent of outright fear. Some patients are highly sensitive to the suggestions of impending pain or discomfort, the sight of blood, the fear of manipulation about the head and neck or the recollection of frightening events related by those who have undergone treatment; even the odors of the hospital corridors or the doctor's office may be sufficiently suggestive to bring on syncopal or hysterical symptoms.

It should always be remembered that circulatory collapse may exist in patients who appear to be entirely well. There are numerous instances of individuals suffering from serious cardiac conditions or even dying en route home from the clinic after undergoing complete physical surveys including cardiovascular studies. Since this catastrophe might occur in the dentist's office, it is well to be reminded that the acceptance of a patient carries with it the responsibility for treatment, including the services of consultants.

While most authorities who care for cases of severe hemorrhage, trauma or wounds would omit the conditions discussed below from those considered to be true shock, there remains the fact that the shock or shock-like states incident to these conditions are indeed "shocking" to the patient, the dentist and to those about them. It must also be remembered that the less significant causes of the shock-like state may well be precursors to and may blend into true shock states. For this reason those conditions occurring in the office of the dentist which bring about faintness, syncope or collapse must be recognized. Where the possibility exists that these occurrences may be the indications of serious conditions requiring the attention of the physician or surgeon, the dentist must call freely upon the services of the physician, especially if there is doubt.

The conditions to be discussed may appear during the preparation for treatment or may occur during or following treatment in the dental chair. These include syncope, hysteria, cardiac and certain other circulatory conditions, drug sensitivity and anaphylactoid reactions, vasovagal syndrome, certain neurogenic influences on the circulatory system, hemorrhage and angioneurotic edema.

SYNCOPE

Simple syncope rarely occurs in young children. It usually occurs where fear dominates. The patient exhibiting undue concern or fear should be spared any acts on the part of the dentist or his assistants which might suggest the possibility of pain, bleeding or serious consequences incident to treatment. Confusion, the sound of the handling of instruments, sudden extraneous noises and unnecessary conversation must be avoided. These patients require inculcation of the feeling of confidence in the doctor and his ancillary personnel. They should be informed of what to expect and should be handled in a firm but kindly manner. Frequently after the first appointment these patients return with confidence and exhibit none of the signs of fear and do not create the problems of syncope. Occasionally, however, the administration of barbiturates, 1 to 2 hours prior to treatment, may be advisable. Should this be required, it should be remembered that such patients should not drive their cars and should be escorted to the office and back to their homes. A physician or dentist may be legally liable for the actions of patients to whom he has administered these drugs.

HYSTERIA

The manifestations of mild or severe hysteria are well known. It is occasionally difficult to differentiate between true hysteria and simple syncope or other conditions which produce semi-conscious states. Familiarity with the reaction of these patients under stress is of value. It is frequently possible to anticipate from their actions and expressions those who are candidates for hysterical manifestations in the office. During a hysterical manifestation it will be noted that there is little change in the pulse or blood pressure. It is helpful to recognize that these patients will resist efforts to raise the upper eyelid or to change their posture and they will respond effectively to pressure on the supraorbital nerve or to painful stimuli, such as stimulation by grasping and squeezing the musculature of the inner aspect of the thigh. Responses to these stimuli frequently bring about resistance and prompt recovery, while they will be ineffective in states of true syncope.

CARDIAC DISORDERS

It is well recognized that coronary heart disease is present not only in the older age group but also in many below the age of forty. Cardiac causes of shock-like states in the dentist's office may be those due to abnormal cardiac rhythm or to disease of the coronary vessels which

supply the heart muscle. Transient faintness or unconsciousness may occur during brief periods of extrasystole or of ventricular fibrillation. Abnormality of the pulse rate or rhythm should prompt immediate consultation with a physician.

Coronary heart disease may be manifested by severe vise-like pain in the region of the heart which frequently radiates down the left arm. Most patients will give a history of such attacks and may well inform the dentist of the nature of their disease when the pain strikes. The majority will be found to have nitroglycerin tablets on their person which may be administered sublingually. The pain from coronary spasm may be extreme and death might ensue with or without coronary occlusion. Occlusion of the coronary artery at the site of or distal to an arteriosclerotic plaque may be manifested by the symptoms of coronary spasm or may progress immediately into collapse and death.

Any cardiac manifestations should prompt the dental surgeon to seek the immediate assistance of the physician. It is well to be overcautious where cardiac disease is suspected, even to the extent of requiring the patient to be removed from the office by litter to the physician's office or to the hospital for observation and care.

CIRCULATORY DISORDERS OTHER THAN CARDIAC

The most common cause of circulatory collapse in the office patient is that due to neurogenic disorders. It will be recalled in the experiments of physiology that stimulation of the vagus nerve results in a dramatic slowing of the heart rate and a pronounced fall in blood pressure. Structures of the head and neck are richly supplied by branches of the vagus nerve or by those of other elements of the autonomic nervous system which engender responses of the vagal system. Certain other areas of the body are very sensitive to strong stimuli. A blow to the testicle or the epigastrium can bring about immediate circulatory collapse. Under these conditions there is a widespread vasodilatation of the capillaries of striated muscle. It is stated that the capillaries of the striated musculature of the thigh alone would accommodate half the circulating volume of blood if all the capillaries were widely dilated. It is evident that under these conditions an inadequate blood flow to vital centers may occur within seconds. Thus, syncope may ensue. Manipulation of the neck which produces pressure at the bifurcation of the carotid artery may result in a similar syndrome. This is due to the stimulation of the carotid body which produces a marked fall in blood pressure.

The immediate treatment for circulatory collapse due to the various neurogenic stimuli mentioned above is the removal of any constriction

about the neck and the immediate placing of the patient in the supine position with the head lowered. This should result in a rapid and complete recovery but it must always be remembered that the cardiac conditions described above, as well as embolism, may be lurking in the background and that the stress on the circulatory system due to neurogenic collapse may precipitate a more serious cardiac condition.

Syncope is usually ushered in by pallor, a sense of nausea and giddiness accompanied by sweating. In patients who complain of faintness or who actually develop syncope, the pulse rate will be found to be slow in the early moments. There is a slight fall in blood pressure. The patient should not be caused to lean forward with the view to increasing intra-abdominal pressure as well as lowering the head. The possibility of falling forward from the dental chair is thus avoided.

Inhalation of aromatic spirits of ammonia is effective in bringing about a response. Care should be taken to avoid holding the drug too close to the mouth or nose, since inhalation of this drug is a strong stimulant. In true syncope the initial reaction to this stimulus may be minimal. In hysteria, an equal stimulus will usually result in a very effective demonstration of resentment on the part of the patient. Aromatic spirits of ammonia may be given by mouth but must be well diluted—2 cc. in 30 cc. of water will usually suffice.

DRUG SENSITIVITY

In the dental office the most common substances which may produce drug reactions are the local anesthetic agents and penicillin.

Sensitivity to Local Anesthetic Agents

The high incidence of collapse and death encountered during the period when cocaine was the local anesthetic of choice has relegated this agent to the background. In ophthalmology, where cocaine must be used on occasion, it has become necessary to prepare fresh solutions for each use and to be ever alert to the possibility of collapse following the use of even freshly prepared solutions; even the topical application of cocaine may be dangerous.

Though few patients are sensitive to local anesthetic agents now in use, the incidence of reaction to these drugs requires that measures be at hand to combat reactions. The small amount of epinephrine used with these drugs probably prevents reactions in some who are slightly sensitive to the anesthetic. Premedication with barbiturates is highly effective in preventing reactions. Immediately upon injection of small quantities of the anesthetic agent, hyperventilation, fear, loss of con-

sciousness or convulsions may be followed by dyspnea, pulmonary edema and asystole with a rapid decrease in blood pressure and death.

Upon recognition of the earliest signs of such reactions, treatment must be instituted immediately. Control of asphyxia takes first priority. It becomes necessary to remove the patient to a litter or bed and to administer artificial respiration. Oxygen should be at hand and must be given by mask rather than nasal catheter. Even if oxygen is administered, effective artificial respiration must not be neglected.

The second requirement is to administer intravenously a sufficient amount of a fast-acting barbiturate to control the convulsion. It is even preferable that an assistant attempt to give the barbiturate simultaneously with the institution of artificial respiration. It is possible that such a patient might expire from anoxia while an operator is searching for a vein. In this state the peripheral veins might be in collapse. The barbiturates most commonly used are secobarbital (Seconal) or Pentothal sodium—2 to 5 cc. of a 2.0 to 2.5 per cent solution being used. Ampules of these drugs together with sterile hypodermic syringes and needles should be readily at hand wherever local anesthetic agents are administered.

Anaphylactoid Reactions to Penicillin

Sensitivity to penicillin is becoming a serious problem. The indiscriminate administration of penicillin has sensitized thousands of individuals who cannot now tolerate even minimal doses of that agent. There is no certain method by which those sensitive to penicillin can be recognized. The fact that the patient has had previous injections without untoward effect is not sufficient evidence that further administration is safe. Many patients are aware of the sensitivity and the lay press has impressed many who have asthma or hay fever with the danger of sensitivity. With this in mind, the operator should respect any patient's solicited or unsolicited statements concerning any previous difficulties encountered after the administration of not only penicillin but also local anesthetic or other drugs. The use of penicillin as a prophylaxis against infection is to be decried, mainly because of the possibility of anaphylactoid reaction upon administration of further doses of the drug.

There are a variety of types of allergic reactions to penicillin, but the two most important are the delayed serum sickness type and the immediate anaphylactoid variety. A large percentage of anaphylactoid reactions occur in persons usually suffering from asthma or hay fever. A large number of such patients have had allergic symptoms, such as hives or asthma, from previous administration of penicillin. The vast

majority have had penicillin in the past. Anaphylactoid reactions have been reported not only to parenterally administered penicillin but to orally administered penicillin as well. Undoubtedly, such reactions may also be attributed to the procaine fraction of penicillin procaine complexes.

The majority of severe anaphylactoid reactions occur in a few seconds to ten minutes. The clinical picture is the result of involvement of all body tissues, with manifestations of shock and often with the addition of extreme respiratory distress—even cessation of respiration —vomiting, loss of consciousness and even loss of sphincter control. Death may occur in a matter of minutes. Recovery may be spontaneous or due to treatment. The patient, after recovery from the shock, may develop more classic manifestations of allergy, including generalized urticaria, vasomotor rhinitis and asthma. Weakness and exhaustion are the rule after recovery. Anaphylactoid shock is a truly medical emergency, in which the earliest detection of its onset and the vigorous institution of judicious treatment will often prevent a fatal outcome.

Treatment. Treatment falls into two categories, general measures and the administration of drugs.

General measures which should be employed are:

1. Placing of the patient in a supine, head down position, preferably on a litter or a bed so that artificial respiration can be administered.

2. Placing a tourniquet, if possible, above the site of any subcutaneous or intracutaneous injections of the suspected allergen. Pressure should occlude the arterial pulse and this pressure should be released periodically for comfort. The reason for injecting penicillin into a muscle of the thigh or arm is thus understood. The site of injection must be low enough on the extremity to allow application of a tourniquet between it and the central circulation.

Drug therapy includes the following:

1. Epinephrine aqueous, 1:1000, is the first drug of choice. Alone it will give relief, particularly if given at the onset of symptoms and if the absorption of the allergen is reduced by use of the tourniquet. The average adult dose is 0.25 to 0.50 cc., given deeply but subcutaneously, with gentle massage at the site of injection. The epinephrine is more effective if given in smaller doses, repeated at a different site, at an interval of ½ to 2 hours.

2. In protracted shock with a thready pulse and persistently low systolic pressure, intravenous 5 per cent glucose in normal saline with 10 to 50 mg. of Neo-Synephrine per liter of solution should be started and continued slowly until normal blood pressure is re-established.

3. Antihistaminics, in soluble form, given intravenously, will add to the rapid recovery from the shock picture and will reduce the later

developing urticaria and mucous membrane edema. The choice of the soluble antihistaminic is not important and dosage may be one-half that of the drug in capsule or tablet form. At the time of the initial intravenous injection, the same dosage may be given intramuscularly and repeated every 4 hours, as clinical symptoms warrant.

4. Soluble theophylline preparations, given slowly intravenously by introduction into the glucose and saline solutions in dosage of 0.25 gram, are of value when respiratory distress not relieved by epinephrine alone is a part of the shock picture.

HEMORRHAGIC SHOCK

The patient in the dental office will rarely develop shock due to hemorrhage alone. Blood loss usually seems to be much greater than actually occurs. In the absence of syncope due to apprehension or the sight of blood, hemorrhage must be extensive to bring about true syncope. An individual of average weight has a blood volume equal to approximately 8 per cent of the body weight. Thus, one weighing 150 lbs. has approximately 12 lbs. of blood, which is roughly equal to 12 pints. A loss of 30 per cent, or approximately 3½ pints of blood, will usually result in marked hemorrhagic shock. The loss of less than 2 pints in the absence of fear or apprehension is usually unassociated with serious shock. The large number of people who have contributed one pint of blood is ample evidence that the loss of this amount of blood should not cause symptoms of significance in the dental office.

On those rare occasions in which massive blood loss occurs active treatment must be instituted. This includes not only lowering of the head in the supine position but also the replacement of blood volume either in the form of whole blood or as plasma or one of the plasma expanders. Under these conditions, consultation with one experienced in the surgery of trauma is of great value.

ANGIONEUROTIC EDEMA

Though angioneurotic edema is not included in most discussions on shock, the rapid development of edema about respiratory passages in this disorder results in symptoms similar to many of the conditions described above. Edema may rapidly embarrass respiratory exchange and may in the more extreme cases require tracheotomy.

* * * * *

The more common conditions which produce shock or shock-like states in the dental office have been discussed. In addition to these, it is vital to exercise great care in the treatment of patients with chronic

debilitating diseases, especially those conditions associated with chronic blood loss. Individuals who develop anemia over a long period of time may seem to be in a satisfactory physical condition. The only evidence of illness may be paleness of the skin and mucous membranes. The hemoglobin content, however, may be extremely low and the red cell count can be less than 2 million per cubic centimeter of blood in some patients with chronic anemia who are unaware of the gravity of their illness. In these cases the balance between circulatory sufficiency and circulatory collapse is very delicate. A suspicion of anemia should prompt consultation with the physician and patients of this type should not undergo major dental procedures until assurance from the physician is obtained.

In this age of threat of atomic warfare, members of the dental profession will be found derelict if they are content with the treatment only of shock and shock-like states discussed in this paper. Far more serious is the treatment of shock due to trauma, burns, or hemorrhage among mass casualties. In case of atomic warfare little dental care will be demanded in the earliest hours of the catastrophe.

A careful review of the standard text on the mechanism and treatment of shock under these conditions will keep the members of the dental profession qualified to assume many roles of the physician or surgeon in the treatment of mass casualties. It may well be that all minor fractures, burns and soft tissue injuries might be diverted to the dental profession for care while those experienced in the surgery of trauma will be overwhelmed in the care of the cranial, thoracic and abdominal injuries.

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Emergency Management of Acute Sensitivity Reactions

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Sensitivity reactions that occur as emergencies in dental practice can be due to a number of mechanisms which differ from the pharmacologic effect of a drug, or from the effect of an overdose—assuming, of course, that the substance has been given in recognized therapeutic doses. A reaction can be designated as hypersensitivity, as allergy, or as an idiosyncrasy. No matter what term we use, the over-all picture is that of hypersensitiveness.

If the reaction is truly allergic, there must be an interaction between antigen and antibody. The latter, in most instances, has been acquired by a previous contact. The antigen must be protein in nature to produce sensitization, but a hapten, which is an incomplete antigen, may combine with protein, and in so doing, become antigen. This product of the linkage between protein and nonprotein substance can produce sensitization, but the hapten itself can elicit a reaction after sensitization has been accomplished. A great many drugs and other agents used in dentistry can be classified either as haptens or as antigens.

There are many degrees of allergic reaction: dermatitis, urticaria, angioneurotic edema—all the way to a shock-like or anaphylactoid reaction. Any shock organ in the body may be involved. It has been postulated that the cellular theory of allergy implies that antibody is attached to the cells, and no reaction occurs until antigen comes in contact with antibody in the sensitized area. It is possible that this combination here produces histamine or a histamine-like substance, which pharmacologically mediates the whole mechanism of allergy.

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Heredity probably plays a very important role in the so-called atopic individual. Here we find the person who has a high titer of reagin, or skin-sensitizing antibodies, which are the antibodies involved in the overwhelming reaction which frequently occurs. But in dealing with drug sensitivity and with other substances which produce acute reactions that require immediate and forceful measures, let us not forget that the so-called nonallergic individual can, in many cases, be as readily sensitized by contact with certain antigens as the highly sensitive, so-called allergic individual. For this reason, unnecessary contacts with known sensitizing agents should be avoided as much as possible.

The duration of sensitization is variable and particular in most instances. It may last for two weeks, or much longer—in most instances, possibly during the entire life of the individual. The type antibody, and its distribution and concentration, determine to some degree the severity and kind of reaction elicited. Spontaneous allergic manifestations have been designated as qualitative, by definition, but certainly reactions that produce shock also may be quantitative. Therefore, some disturbing manifestations may be avoided by careful attention to dosage.

When we speak of drugs and other substances producing an allergic reaction, we think of antigens which are non-poisonous or innocuous to normal individuals; not toxic substances. The reactions are due to altered reactivity.

In addition to allergic reactions, other emergencies may arise, which are due to other actions: (1) overdosage; (2) toxicity and intolerance; (3) shock occurring with therapeutic doses, accompanied by convulsive seizures and respiratory and circulatory failure.

EMERGENCY ARMAMENTARIUM

Some of the dangerous reactions mentioned above may be completely unexplainable. Reactions of all types may sometimes occur no matter what precautions we take. Therefore, it is necessary to have at our command means to combat dangerous emergencies that arise from the administration of drugs. The armamentarium which is necessary to combat an allergic or anaphylactoid type of reaction and which should be constantly on hand is:

1. Epinephrine (Adrenalin) 1:1000 dilution.
2. Parenteral antihistamine drugs: Benadryl (diphenhydramine) solution, 10 mg. per cc. Other antihistamines may be efficacious, but Benadryl is probably the one of choice.
3. Hydrocortisone, 2 cc. ampules containing 100 mg. each.

4. Aminophylline for intravenous use—10 cc. contains 0.24 gram of theophylline with ethylenediamine.

5. Equipment for resuscitation, artificial respiration and administration of oxygen.

6. Levophed, 4 cc. ampules, 0.2 per cent solution.

Measures to combat the effects of overdosage fall under the heading of toxicology, and specific antidotes are necessary. For toxicity and intolerance, such as that from cocaine and procaine, parenteral barbiturates are indicated. Intravenous preparations of short-acting, intermediate-acting or even long-acting barbiturates may be used. Suggested are phenobarbital sodium, sodium Amytal, Nembutal, and Seconal sodium. Sodium Amytal is available in ampules containing 0.25 gram (3¾ gr.) or 0.5 gram (7½ gr.), with diluting solutions for intravenous use.

DRUGS THAT MAY INDUCE SHOCK-LIKE REACTIONS

Drugs frequently used in dentistry that may precipitate or induce a shock-like reaction are:

Local anesthetics: cocaine, procaine (Novocain, Neocaine), Monocaine, tetracaine, Pontocaine. Other local anesthetics that may possibly be substituted for procaine, and have an individual specificity, are Nupercaine and Xylocaine. Cocaine also has a definite specificity, but is not used for infiltration anesthesia.

Mercurials, iodides, penicillin, streptomycin, vitamin preparations and liver extract, hormonal extracts, radiopaque material, aspirin and sulfonamides.

General anesthetics: ether, nitrous oxide, Pentothal sodium (thiopental).

DIAGNOSIS OF HYPERSENSITIVITY

It may be possible by diagnostic tests to determine the degree of sensitivity of a patient, although in many cases this is impossible. Skin tests can be done by the scratch or intracutaneous methods; patch tests may also give us some information.

Scratch Tests. Scratch tests are performed with a screwdriver-like instrument which produces a scratch about ⅛ inch long, and the material is applied to this area. A positive reaction is the formation of a wheal with or without pseudopods, and some erythema. This is read in 15 to 20 minutes.

Intracutaneous Tests. Intracutaneous tests are undertaken for certain preparations; namely, procaine, penicillin, streptomycin, and others. The test is performed by injecting 0.03 cc. of the material intracu-

taneously (intradermally). A 1 per cent solution can be used with safety in most instances. For penicillin, some observers have advocated that the test dose be 100 units, and others have advocated 1000 units. I think the former is desirable. This test is read in 15 to 20 minutes, a positive reaction being indicated by an increase in the size of the wheal, pseudopod formation, erythema, and possible itching. There also may be a delayed reaction in 24 to 48 hours—a so-called tuberculin-like reaction, the exact significance of which is not entirely known. In skin testing preceding infiltration anesthesia, it is possible to test for procaine by the intracutaneous method. A solution of 1 per cent procaine hydrochloride can be injected intracutaneously in a dosage of approximately 0.03 cc.

Patch Tests. For patch-testing, the substances to be tested are applied to the skin of the arm or back and covered with cellophane or gauze held on with adhesive. If any itching or burning occurs at any time within 24 or 48 hours, the patch should be removed and the area cleansed. A positive reaction is signaled by an eczematoid type of response, which may be of varying size. This test is usually used for contact dermatoses and reactions of the skin, and not for proteins which are carried to the shock organ by the circulation.

A positive reaction to any of the above skin tests probably means sensitization of some type or another, but a negative test does not rule out the existence of hypersensitivity, and for this reason the clinical history means a great deal more than skin testing. If substitutions are made for positive reactors, these also should be tested the same as the primary drugs.

CONTROL OF HYPERSENSITIVITY REACTIONS

Often, after all precautions have been taken from the standpoint of history taking, skin testing and careful adherence to dosage, a constitutional reaction will occur which requires emergency therapy. This makes it necessary to have at hand the preparations necessary for management and control of shock. It may be impossible to determine definitely whether a shock-like reaction, fatal or not, is due to allergy or so some other mechanism. It is our purpose here to outline the methods used for the control of reactions due to hypersensitivity. Fatal reactions fortunately are rare, and reports of most of these fatalities reach the literature. But many non-fatal shock-like reactions are not reported, and when they are presented, the management of the case at the time of the reaction is not reviewed. Some means of control are different in dentistry from other medical practices for obvious reasons. In the latter, injections are commonly given in the extremities, and

when they are, a tourniquet can be employed. If the injection is intracutaneous or subcutaneous, possibly multiple punctures may be beneficial. Around the mouth, certainly the use of a tourniquet is impossible and multiple punctures might be inadvisible.

Epinephrine

Epinephrine (Adrenalin) is the drug of choice in constitutional reactions due to allergy. It can be given subcutaneously, intracutaneously and intravenously if necessary. This drug is inactive if given by mouth.

The pharmacologic actions of epinephrine are much like those induced by stimulation of the sympathetics. It acts on the effector cells directly. Denervation of effector organs increases their sensitivity to epinephrine. There are both stimulating and inhibitory effects on certain structures. The nature of the receptor substance determines which will react.

Epinephrine has a marked action on the heart, blood vessels and certain smooth muscles. In certain instances it is a vasoconstrictor, cardiac stimulator and bronchodilator.

The dilution used for parenteral injection is 1:1000, and the dosage is from 0.25 to 1 cc. of the aqueous solution. Epinephrine in oil (slow epinephrine) and in gelatin are too slow in action for emergencies. The doses can be repeated as necessity arises. If given intravenously it is best given diluted in saline, 0.25 cc. of epinephrine in 10 cc. of normal saline. At times it may not be feasible to mix the epinephrine with saline solution. Intracardiac epinephrine can be used in the face of severe exigencies. For purposes of resuscitation, epinephrine can also be used in a 500 cc. infusion of 5 per cent glucose in saline. This is true if repeated absorption of antigen continues.

Levophed

Levophed (levarterenol) is a potent pressor antidote for shock because of its powerful vasoconstrictor action. It is recommended for the maintenance of blood pressure in acute hypotensive states such as may occur in hemorrhage, spinal anesthesia, trauma and other states, also in drug reactions. Levophed is used in prolonged hypotensive states accompanying shock, and not for immediate administration as is epinephrine. Levophed is given intravenously, 4 cc. of a 0.2 per cent solution in 1000 cc. of 5 per cent glucose in saline. It may be necessary to give this infusion over a period of several days. It is an irritating solution, and care must be taken to keep it in the vein, to prevent extravasation into the tissues. Close supervision must be maintained

over the blood pressure as it approaches normal levels. Flow must be carefully regulated to suit the blood pressure. Plasma or whole blood may be given simultaneously with Levophed.

There are, of course, certain types of shock in which vasoconstrictors are contraindicated, but this is not true of shock due to hypersensitivity, or so-called allergic shock.

Antihistamines

Antihistamine drugs are much more effective in preventing anaphylactic shock from injected histamine in laboratory animals than the shock from antigen. Antigen in contact with antibody in sensitized cells may liberate histamine. Antihistamine drugs exert their action more readily on histamine that reaches the effector cell by the circulation than that generated intracellularly.

Antihistaminics act on the central nervous system by both stimulation and depression. They are sympatholytic, have slight effects on smooth muscle and the cardiovascular system, and also have marked local anesthetic action.

There are many antihistamine drugs on the market at the present time. It is apparent that the more side effects drugs have, the more potent they are; their side effects are part of the pharmacologic action.

We choose Benadryl (diphenhydramine hydrochloride) because of its action and availability. It can be obtained in a sterile solution of 10 mg. per cubic centimeter for parenteral administration. It can be given intramuscularly and intravenously. The dosage varies anywhere from 1 cc. (10 mg.) to 10 cc. (100 mg.), depending on the degree of reaction. It is a valuable adjunct, along with epinephine, in the treatment of shock due to hypersensitivity. This drug is also available as an elixir and in capsule form, for oral use.

Also on the market are Chlor-Trimeton (chlorprophenpyridamine maleate), Pyribenzamine (tripelennamine hydrochloride), Thephorin (phenindamine tartrate), Neo-Antergan (pyrilamine maleate), Phenergan (promethazine hydrochloride), Histadyl (methapyriline hydrochloride), Perazil (chlorcyclizine hydrochloride), Teldrin (chlorprophenpyridamine maleate), Decapryn (doxylamine succinate), and others pharmacologically about the same. No antihistamine drug is outstanding, with the possible exception of Benadryl.

Hydrocortisone and ACTH

Hydrocortisone is available in 2 cc. ampules containing 100 mg. of soluble hydrocortisone hemisuccinate sodium (Solu-Cortef, Upjohn).

This can be given intravenously over a period of ½ to 1 minute, followed by 50 mg. in 1, 3, 6 and 12 hours. Or the 100 mg. can be given by infusion in 500 cc. of 5 per cent glucose in normal saline, followed by 50 mg. in 1, 3, 6 and 12 hours. This preparation is a valuable adjunct in the treatment of allergic shock, particularly if there are frequent recurrences of the shock reaction.

Also listed as a drug used in the treatment of shock is ACTH, but for dire emergencies the action of this drug is too delayed to be used. Dependence must be placed entirely on the patient's own adrenals, and for this reason hydrocortisone is preferable. If ACTH is used, it can be given in a dosage of 10 to 40 units, intramuscularly or by slow infusion intravenously.

Aminophylline

Aminophylline (theophylline with ethylenediamine) also may prove valuable in the treatment of shock due to hypersensitivity, especially when there is marked bronchospasm. This preparation also can be given intravenously, in a dosage of 1 to 2 cc. per minute. It is available in 10 cc. and 20 cc. ampules containing, respectively, 0.24 gram (3¾ gr.) and 0.48 gram (7.5 gr.) of aminophylline. This also can be given by slow drip infusion.

Drug Combinations

We have found it efficacious in some cases of allergic shock which persists over a period of time to use a combination of the following drugs in a slow infusion of 500 cc. of 5 per cent glucose in saline:

1 cc. epinephrine 1:1000
5 cc. (50 mg.) Benadryl, 10 mg. per cc.
2 cc. (100 mg.) hydrocortisone
or 40 units ACTH
0.24 gram (3¾ gr.) aminophylline

This combination may be very beneficial if the patient has a tendency to relapse from time to time. This infusion also may be given without the epinephrine, and the latter may be given, in a 1:1000 dilution, hypodermically at intervals of 1 hour, or more often if necessary.

Oxygen

For cyanosis and anoxia accompanying bronchoedema and bronchospasm present in severe shock, oxygen may be given by inhalation. This is preferably administered by use of a BLB mask or a nasal

catheter rather than in an oxygen tent. The flow and amount of oxygen is much more easily controlled out of the tent.

Barbiturates

Barbiturates may be used to allay nervousness and apprehension following the use of epinephrine and possibly aminophylline, but it has been found that Benadryl often takes the place of barbiturates and, along with its other pharmacologic actions, is probably more efficacious than barbiturates for the treatment of an allergic reaction.

REACTIONS TO PENTOTHAL SODIUM

Although reactions to Pentothal sodium (thiopental) do not come under the heading of hypersensitivity, there are certain associations with allergic manifestations that need to be stressed. It is not too uncommon for laryngospasm and bronchospasm to occur, and it is within the realm of possibility that this may occur more readily in a patient who has hypertrophy of smooth muscle of the bronchi. Although a careful résumé of the patient's history might be necessary in an asthmatic before intravenous anesthesia, Pentothal sodium is not contraindicated in this disease. It has been reported that sodium succinate is an effective antidote against Pentothal sodium.

Evipal (Winthrop) is an intravenous anesthetic which acts the same as Pentothal sodium, but it is reported that it does not induce laryngospasm.

PREVENTION OF HYPERSENSITIVITY REACTIONS

If, from the history or the reactions to skin testing, a mild or moderate hypersensitivity is found to be present in a particular individual, and it is essential that he receive a local anesthetic or any other reacting drug, this might be accomplished by incorporating antihistamine drugs with the required agent. Benadryl can be included in the injection itself or it can be given parenterally elsewhere, or it might even be given orally preceding the use of the mildly reacting drug. Epinephrine in various dilutions has always been used to prolong the effect of a local anesthetic. Although this is the action desired, it may also have the effect of preventing to some degree the shock mechanism, but the drug of choice here is the antihistaminic. Not too much dependence can be put on the prophylactic use of antihistaminics this way, but they may prove valuable in selected cases.

The reactivity of an individual varies from time to time, so great

care must be exercised in using antihistaminics orally or parenterally to prevent reactions.

Any history of hypersensitivity of any duration is to be carefully considered. Nothing can be taken for granted. All precautions must be observed to prevent shock, and if it does occur, the materials necessary to combat it must be at hand, as the shock reaction due to hypersensitivity is often immediate and severe, and can occur without any other manifestation of allergy. This is especially true if it is immediate. Urticaria, angioneurotic edema, bronchospasm, laryngeal edema, cerebral manifestations, epileptiform seizures, generalized pruritus, flushing of the skin, nasal block, semi-comatose states or coma may accompany the shock of a hypersensitivity reaction. All of these symptoms can occur together, or they can come on singly at various intervals. Any one or all may precede the shock reaction. Shock due to hypersensitivity may itself come on without any warning.

When a patient presents himself for evaluation for anesthesia, diagnosis or therapeusis, it is well to look at the problem of reaction and shock prophylactically. One should question the patient regarding the following factors in his history:

1. Hereditary history of allergy, especially hay fever, atopic eczema, urticaria, angioneurotic edema and bronchial asthma.
2. Past or present personal allergic manifestations in the patient himself.
3. Any drug idiosyncrasies previously demonstrated.
4. Repeated contacts with a well known sensitizing agent, and mode of administration.

If a positive history is elicited, then it is well to substitute another preparation not antigenically the same. Epinephrine (Adrenalin), Levophed (levarterenol), Cobefrin and Neo-Cobefrin (levonorephedrine) are incorporated in infiltration anesthesia for local action, but certainly are not present in sufficient quantity to prevent shock due to hypersensitivity. Xylocaine, Ravocaine, Primacaine, and other local anesthetics which do not cross-react with procaine (Novocain) may be substituted for the latter. Broad spectrum antibiotics may be substituted for penicillin, penicillin O for penicillin G (although 15 per cent of patients sensitive to penicillin G also react to penicillin O). Sulfonamides also may be substituted for penicillin.

Some drugs have no replacement, and for them another procedure may be necessary; for instance, nitrous oxide gas may be substituted for pentobarbital sodium, or vice versa. It may be necessary to use general anesthesia, such as Pentothal sodium, if the patient is highly sensitive to all types of infiltration anesthesia.

The dosage of all the drugs suggested for the treatment of shock due

to hypersensitivity is variable, depending upon the patient's condition and the effect desired.

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Planning for Good Results in Maxillofacial Fractures

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PRELIMINARY TREATMENT

In treating maxillofacial fractures, as in any other injury, the total patient must be considered first, not just the local area. A patient with injuries of the facial bones seldom dies, except as a result of associated fractures of the skull or ethmoid bone. However, the patient's general condition must be examined carefully before any treatment of the injuries of the facial bones is accomplished. Even before this, first aid measures may need to be taken, such as arresting hemorrhage and establishing an airway. Hemorrhages about the face are not usually of much concern and can be controlled by the application of hemostats and pressure dressings. However, serious injuries with the possibility of intrathoracic or intra-abdominal bleeding may result in a very serious form of shock. Although it is not within the scope of this article to discuss shock, it is worth while to stress the importance of treating this condition before instituting any other treatment.

Establishment of Airway

Frequently, the establishment of an airway in an unconscious patient is overlooked. Often severe injuries about the oral cavity may cause obstruction of the air passage, such as by the tongue falling back into the pharynx. With detachment of the extrinsic muscles of the tongue due to loss or injury of the anterior part of the mandible, the tongue will tend to fall back. A suture inserted into the tongue and taped or tied to something stable on the patient will hold the tongue forward. A collection of blood clots may so obstruct the oropharynx

The opinions or assertions contained in this article are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

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that breathing is impossible. This can be controlled by lowering the patient's head and cleaning out the clots with an aspirator. Occasionally, a tracheotomy is indicated when there is considerable edema about the larynx.

Management of Soft Tissue Wounds

Soft tissue wounds of the face are best treated as soon after the injury as possible, provided that the patient's general condition can tolerate it. The suturing of lacerations within hours is very advantageous, because it prevents infection of the soft tissue as well as of the underlying bone; also, the degree of inflammation is lessened, and in the end the scar is minimized. In débriding the soft tissue and bone, the surgeon must be extremely conservative in order to prevent loss of vital tissues which are helpful in the end result. The early institution of some broad spectrum antibiotic is helpful in preventing infection. If it is impossible to suture lacerations immediately, then after the infection has subsided, the approximating tissues may be freshened and sutured. If soft tissue has been lost by infection or trauma, it is important to cover the underlying bone by plastic surgical procedures as soon as the infection subsides. However, this does not preclude reducing the maxillofacial fractures before treating the soft tissues. Complete serologic tests, blood counts, and urinalyses should be performed to rule out systemic diseases which should be treated and controlled to insure healing of the injuries. Tetanus antitoxin should be administered to patients with contaminated wounds.

Determination of Neurologic Status

If the patient has been unconscious for some period after injury, it is important to seek consultation with a neurosurgeon in order to rule out brain damage. The oral surgeon can quickly evaluate the neurologic status by comparing the reflexes of one side with those of the other, and by noting the presence of a positive Babinski sign, ecchymosis in the area of the mastoids, and positive eye findings. Frequently, in severe fractures of the facial bones there are associated fractures of the cribriform plate of the ethmoid bone. Drainage of cerebral spinal fluid from the nose is positively diagnostic of such fracture of the cribriform plate. Consultation and treatment for this condition is important in view of the fact that meningitis may develop. However, broad coverage with antibiotics has lessened the possibility of this infection. It is best to defer manipulation and management of

the facial bones until this cerebral fluid leakage seals off. Infrequently, spicules of bone may protrude into the brain, and an operation for removal is indicated before manipulation of the facial fractures is undertaken.

TREATMENT OF MAXILLOFACIAL FRACTURES

Assuming that the patient is free of, or has been cleared of, any neurologic damage associated with his injuries, and that manipulation of the fragments is not contraindicated, reduction of the maxillofacial fractures is indicated. The objective in treating fractures of the facial bones is to restore the original occlusion of the teeth, normal function of the jaws, and normal anatomic relationship of the face. Hurried reduction and fixation without adequate diagnosis and planning may produce poor results and in the end may waste time and subject the patient to unnecessary procedures. Careful attention to every injury of the facial bones is important in order to prevent subsequent disfigurement. Swelling of the face may mask the defect in the fresh injury.

First, it is necessary to demonstrate the fractures roentgenographically. Roentgenograms of the bones of the face, as well as dental roentgenograms, are invaluable for this purpose. Fractures that are difficult to demonstrate roentgenographically, as in the maxilla and zygoma, may be demonstrated by gentle manipulation. Percussion of the teeth in the maxilla will often reveal the extent of fracture in the dental arch. Plaster study models of the dental arches are helpful when the occlusion of the teeth is not normal. These models are an aid in studying the case in order to determine where traction is indicated and whether the end result of fixation is satisfactory. The study models are also helpful in contouring arch bars; they eliminate unnecessary manipulations in the mouth and afford more accurate contouring of the bars to the arches.

The earlier the treatment is instituted, the sooner the patient's apprehension will be allayed and his comfort restored. However, rapid treatment should not be substituted for good preoperative planning. (On occasion, owing to the patient's condition, the author has been forced to delay as long as a month before reducing fractures.)

It is not the objective of this paper to advocate any particular technique in operative procedures. Many methods for reduction and immobilization of fractures of the jaws have been described in the literature. However, no one method is suitable for every case. There are advantages and disadvantages to each type, and one method works well in the hands of one surgeon while the same method may not pro-

duce as good results in the hands of another. However, there are certain principles to which one must adhere.

In order to have successful results, the continuity of the bone and normal occlusion of the teeth must be restored. One may have good union of the fracture, but unless the patient's normal occlusion is established to insure adequate mastication, the case may be considered a failure.

One should strive to get good anatomic alignment of the fragments but it is considered good surgical judgment to accept slight discrepancies due to the technical difficulties such as muscular pull on the fragments, comminution, loss of bone, etc. These discrepancies will be filled in by deposition of bone, and usually within a year's time it is impossible to note the discrepancies roentgenographically, much less clinically.

It is considered good treatment to extract teeth in the line of fracture at the time of reduction, if they are not necessary for fixation purposes. Pulps of teeth whose blood supply may be severed owing to fractures will become necrotic and an abscess may form which could produce osteomyelitis. However, since the advent of antibiotics this condition can be aborted and extractions frequently may be delayed until after healing.

The objective in treating fractures is accomplished by reduction of the fractures, fixation of the fragments, and maintaining the fixation until there is clinical evidence of good fibrous union.

Fractures of the Mandible

All but about 10 per cent of fractures of the mandible can be reduced and fixation can be accomplished by simple intermaxillary wiring. The simplest method is the best method if desirable end results are attained.

Frequently, fractures occur at the angle of the mandible where there are impacted, unerupted, or erupted third molars. If the fracture is severe, displacement usually occurs owing to the pull of the muscles of mastication on the posterior fragment. In these cases, reduction is difficult without some means of direct fixation. Usually the tooth should be removed. By removing an unerupted or impacted third molar through a carefully planned incision in which a mucoperiosteal flap has been elevated, the fracture can be visualized. Holes can be bored at strategic points in the buccal plate of the fragments and the fracture can be reduced and fixed by interosseous wiring. This saves time, because the tooth can be removed at the same time the fracture is reduced. The fracture has been orally contaminated already; the

procedure can be done with a minimal armamentarium under local anesthesia in the dental chair. If, however, this procedure fails or is not feasible, no time has been lost. When the swelling subsides, the extraoral approach for open reduction can be performed. This is technically simpler to one well trained and experienced in surgery, in that the fracture area is more accessible than via the intraoral approach. However, the setup requires a greater armamentarium, more surgical assistance, and should be performed under general anesthesia in the hospital.

It is felt that dislocated fractures of the surgical neck of the condyloid process of the mandible should be treated conservatively, i.e., by intermaxillary fixation with no attempt at reduction of the condylar fracture. These unreduced fractures of the condyle form a pseudoarthrosis, or actual union may occur if displacement is minimal. The only exception to this occurs when occlusion of the teeth can not be attained. Then, extraoral open reduction is recommended, employing some form of interosseous wiring or bone plating of the fragments.

External and Internal Pin Fixation. External pin fixation is the type devised by Roger Anderson, Stader, Haynes and Griffin, and others. Internal pin fixation was developed by Kirschner and Steinmann. Many technical difficulties can be involved in these methods, which can be verified roentgenographically only after surgery. One may think he has an excellent result, clinically, only to be disappointed by the roentgenographic findings. These means of fixation are useful in holding fragments in position, to prevent malalignment by scarring, until bone grafting can be performed. It is felt that present-day methods offer better means of fixation and that pin fixation should be used only as a last resort.

Bone Plates. There are many types of bone plates advocated by many oral surgeons. They should not be used indiscriminately. Metal plates are useful when adequate interosseous wiring is not possible or is awkward in managing fixation of the fragments. They are useful in cases in which small defects exist between fragments where bone chip grafts are indicated.

Bone Grafts of the Mandible. When there is not more than a few millimeters of bone loss in fractures, the packing of bone chip grafts in the defect, along with adequate fixation, is an excellent means of treating these defects.

However, when there is a greater amount of bone loss, a block of bone grafted in position is indicated to restore the continuity of the bone. In order to get maximal contact of the graft to the fragments, an inlay-onlay type is most desirable. The size of the graft is important. With a small piece it is difficult to maintain stability, and in-

evitably the fragments, particularly the posterior one, when there is no tooth in occlusion, will become displaced owing to the pull of the muscles of mastication. The surfaces in contact with the graft must be decorticated to the extent that they bleed freely. The choice of the donor bone is important. Autogenous iliac bone is considered the best for this purpose, but the oral surgeon must rely on an orthopedist to remove the bone and he must use what he gets. Too often this bone is inadequate in its dimensions; for this reason the author prefers preserved bone. This bone can be obtained to nearly exact measurements and it can be shaped prior to surgery, which saves considerable time in surgery. Good fixation of the graft is important, and it can be obtained by the use of stainless steel interosseous wires and some means of intermaxillary fixation.

Fractures of the Maxilla

Unilateral fractures of the maxilla can be reduced by manual manipulation or intermaxillary elastic traction followed by immobilization of the mandible with intermaxillary fixation. However, when there is a complete fracture of the maxilla, such as the horizontal, pyramidal or transverse facial types, it is necessary to reduce the fracture by bringing the maxillary and mandibular teeth into occlusion with intermaxillary elastic traction. When normal occlusion of the teeth has been restored and the fragments are properly aligned, internal transmalar, transnasal, transzygomatic, or transfrontozygomatic wiring to the arch bars are excellent means of support for the mobile maxilla. This maintains the fragments in continuous apposition, fixation is not cumbersome, and the patient is more comfortable during the period of healing. If it is impossible to accomplish reduction by this method, some type of head appliance, i.e., a plaster head cap or head band with extension rod or rods for elastic traction, is indicated. The cranial-skeletal pin fixation appliance is an excellent means of attaining this fixation, because of its great stability. When the teeth attain their proper occlusion and the fragments are restored to anatomic alignment, transfacial wiring from the arch bars to a head appliance for upward traction to support the fragments is necessary until there is a good fibrous union of the fractures.

Fractures of the Zygoma

Simple fractures with displacement can be elevated into position with a towel clip, or some suitable hook, etc. If the fragments do not remain in alignment, an open reduction is indicated with interosseous wiring at the infraorbital and/or the frontozygomatic fracture sites.

Comminuted fractures with displacement are treated by a Caldwell-Luc procedure in order to gain access into the antrum; with finger or elevator pressure the fragments can be aligned into proper anatomic relationship. The conventional means of holding the fragments is by gauze packed in the antrum until there is a fibrous union of the fragments. Also, the Foley retention catheter is an excellent method of holding the comminuted fragments in position. The catheter is passed through an antrostomy made in the inferior meatus of the nose. The balloon at the end of the catheter, which is placed in the antrum via the nasal window, is inflated with normal saline. Then the mucoperiosteal flap in the mouth is closed. After healing of the fractures, the catheter balloon is deflated and removed through the nose.

Depressed fractures of the zygomatic arch can be reduced by either an extraoral or an intraoral approach. In the extraoral method, an elevator is passed under the fragments through an incision in the temporal area and, using the skull as a fulcrum, the fragments are elevated. In the intraoral method, an incision is made behind the malar process in the mucobuccal reflection and an elevator is passed upward and backward under the fractured arch. The fragments usually stay in alignment without any means of fixation.

Choice of Treatment Method

Choosing the best method of treatment for each case is often difficult for the inexperienced surgeon. Training and experience are prerequisites for planning any surgical procedure. The inexperienced surgeon should not hesitate in seeking consultation with a more experienced one. Young surgeons may have a tendency to try involved procedures to gain experience, but this practice is not in the best interests of the patient when a simpler method would produce the same results. The most appropriate questions the surgeon should ask himself are: "Would I approve this procedure on myself?" and "Would I want it done by someone with my experience and qualifications?" If the answers are "no," the surgeon should seek consultation and should probably give the case to a more experienced surgeon or share the case, for the patient's welfare as well as for the doctor's benefit.

Errors in Treatment Planning

Occasionally one sees maxillofacial fracture cases in which unnecessarily cumbersome appliances are employed or else inadequate ones which fall short of proper reduction and fixation. The following case summaries are examples of this and are presented to show the mistakes

made in treatment planning and the resultant poor esthetics and function.

Case No. 1. The patient was a 19 year old man who was involved in an automobile accident and sustained multiple comminuted fractures of the maxilla, right and left zygomas, nasal bones, and mandible, and traumatic avulsion of both eyeballs, along with numerous less serious injuries.

Apparently the preliminary treatment, consisting of a tracheotomy, multiple blood transfusions, and débridement of lacerated wounds with primary closure was adequate, because the patient was transferred to our hospital 3½ months after injury in good physical condition.

At another hospital, attempts had been made to reduce the maxillary and mandibular fractures with cumbersome appliances, which served no purpose. A cranial-skeletal pin fixation appliance had been used in an attempt to reduce the

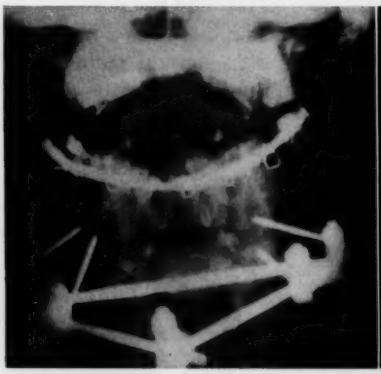

Fig. 1.

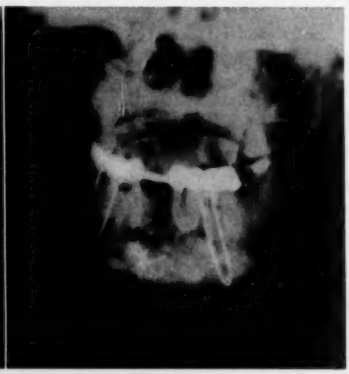

Fig. 2.

Fig. 1. Case 1. Symphysis fracture, 3½ months postoperative, with teeth in the line of fracture and the use of external pin fixation. Clinically, there was suppuration from the areas surrounding the teeth, the fracture and the pins.

Fig. 2. Case 1. Teeth in the line of fracture and external pin appliance have been removed and more direct fixation employed. Patient had union of the fracture after the first postoperative month.

fractured zygomas and maxilla. Clinical and roentgenographic examination revealed no reduction of the maxillary fractures. The maxilla was telescoped and rotated upward and backward and was well healed in this malposition. A Roger Anderson pin fixation appliance was employed to attempt reduction and fixation of a symphysis fracture of the mandible. Teeth in the line of fracture had been left alone and when the patient presented himself at our hospital there was a purulent discharge from the fracture site, from loosened incisor teeth, and from the pins. There was an arch bar wired to the lower teeth which served no purpose (Fig. 1).

Upon arrival here, the Roger Anderson appliance was removed, the teeth in the line of fracture were extracted and, when the infection was controlled, a cast gold splint was constructed and cemented to the teeth. The fracture was exposed from an extraoral approach, the fibrous and granulation tissue was removed, and the eburnated bone ends were freshened. The fracture was reduced and fixation was accomplished by direct interosseous wiring, and the splint was secured with circum-mandibular wiring. The continuity of the mandible was restored and the fracture healed without incident (Fig. 2).

The grossly displaced maxillary fracture was so well healed, however, that the fragments could not be reduced, and the remaining maxillary teeth were extracted in order to correct the intermaxillary discrepancy by a full denture (Fig. 3).

Fig. 3. Case 1. Postoperative photograph of patient showing the unsatisfactory cosmetic results due to poor treatment planning following the accident.

Fig. 4.

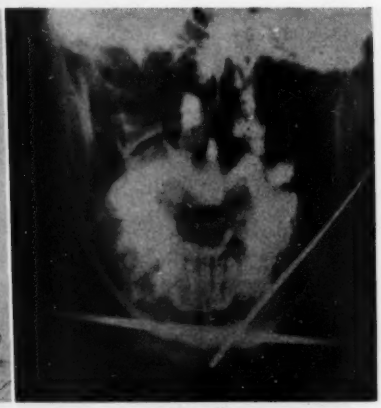

Fig. 5.

Fig. 4. Case 2. Photograph demonstrates poor treatment planning with cumbersome, unnecessary fixation using Kirschner wires.

Fig. 5. Case 2. Roentgenogram demonstrates Kirschner wire separating the fragments instead of maintaining the fragments in apposition.

Case No. 2. A 20 year old man was referred to our service with a compound fracture of the angle of the left mandible, which he sustained from an automobile accident. He was admitted preliminarily at another hospital, where two Kirschner wires were employed with a sailor cap for reduction and fixation of the fracture and immobilization of the mandible (Figs. 4 and 5).

Upon arrival at our hospital, roentgenographic examination revealed the fragments to be separated by the Kirschner wire instead of being held in apposition.

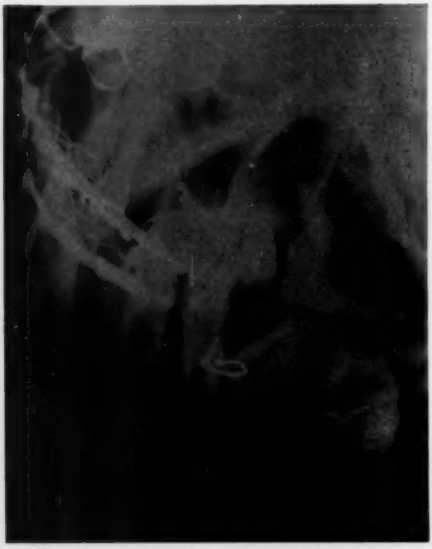

Fig. 6. Case 2. Intraoral open reduction using interosseous wiring and immobilization of the mandible with intermaxillary fixation.

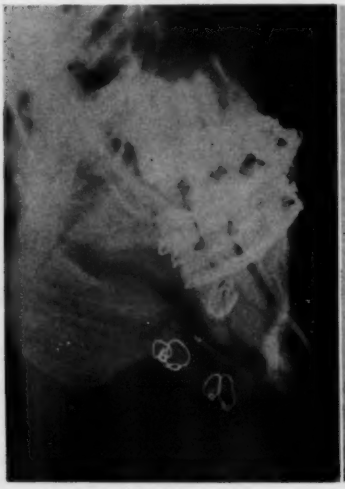

Fig. 7. Fig. 8.

Fig. 7. Case 3. Inadequate autogenous bone graft performed for malunion at the site of ostectomy. Fragments are malaligned and graft is wired inadequately.

Fig. 8. Case 3. Dissolution of the graft from infection following displacement of the posterior fragment; 4 months postoperative.

The teeth were in malocclusion, owing to improper reduction of the mandibular fracture. The wires were removed and the fracture was reduced by an intraoral open reduction with interosseous wiring of the fragments, and the mandible was immobilized by simple intermaxillary wiring (Fig. 6). The patient's recovery was uneventful.

Case No. 3. A 27 year old man had a malunion of the right mandible, owing to an aseptic necrosis which followed an operation for surgical correction of mandibular prognathism. There was about 1 inch loss of bone structure. At another hospital an autogenous bone graft had been performed (Fig. 7). During the period of fixation the fragments became displaced and the graft became infected (Fig. 8).

The patient was referred to our service for further treatment. Examination revealed nonunion and dissolution of the graft with elevation of the posterior fragment. There was a chronically draining fistulous tract.

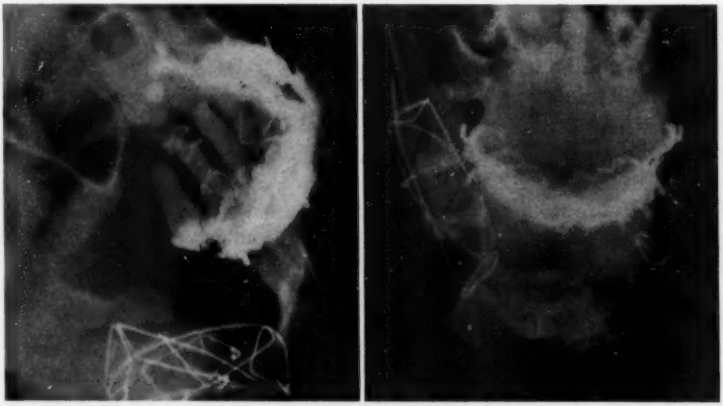

Fig. 9. Case 3. Homogenous preserved bone graft, adequate in size, well fitted, and securely wired in position. Fragments are aligned.

The area was débrided by an extraoral operation and the infection was treated with oxytetracycline. After the area healed and had been clear of any drainage for 2 months, a homogenous freeze-dried bone graft was performed. An inlay-onlay graft was shaped and fitted from roentgenographic measurements prior to surgery. At surgery the fragments were aligned and decorticated, the graft was secured in position by criss-cross interosseous wiring (Fig. 9), and the mandible was immobilized with intermaxillary fixation. At the end of 2 months, there was clinical evidence of good union of the graft.

The success of this second bone graft is attributed to the fact that the graft was of generous size, was carefully fitted in the defect by an inlay-onlay method, and was adequately wired in position with good intermaxillary fixation.

The first attempt failed because the fragments were not aligned and because the graft was inadequate in size and fit and was not properly wired to the fragments.

Duration of Fixation and Immobilization

This factor is variable. One must consider the types of fractures and the patient's healing ability, which varies with age, infection, systemic

diseases, nutrition, etc. Usually 4 to 5 weeks is adequate for the most severe fractures, which are reduced and fixed adequately. A minimum of 8 weeks is necessary for fixation of bone grafts. At the end of this period there will be a fibrous union with no roentgenographic evidence of bone deposition. If the occlusion does not change at this time, some function is beneficial for bone formation. However, if there is a shift in the occlusal relationship, further immobilization is indicated.

Postoperative Care

Patients whose mandibles are immobilized should have high caloric, high protein, high vitamin, liquid diets. Patients whose fractures are compounded, orally contaminated, or infected should be given a broad spectrum antibiotic. All patients with bone grafts should have massive doses of ascorbic acid to help stimulate osteogenesis, and should have antibiotics to insure healing. With the various food blenders available today a liquid diet can be just as adequate as a normal one. Patients should be instructed in the importance of maintaining scrupulous oral hygiene. Intermaxillary wiring is recommended after fractures are completely reduced. This will facilitate brushing the teeth and encourage better oral hygiene.

SUMMARY

In planning for good results in the treatment of fractures of the facial bones, the patient's general physical condition must be considered first. First aid, establishment of an airway, and treatment of shock are first requisites. Patient should have a thorough physical examination and should be cleared by a neurosurgeon, if there are any neurologic symptoms, before fracture treatment is instituted. Fractures should be examined clinically and with adequate extra- and intraoral roentgenogram. Conservative and simple means of treatment are usually the best.

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Diagnosis of Acute Facial Pain

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In this discussion the subject matter will be limited to those conditions characterized by facial pain in which there are no apparent objective signs. (The presence of organic changes makes diagnosis more simple.) Conditions falling into this general category may be listed as follows: (1) pain of dental origin, (2) pain of sinal origin, (3) pain from major tics (trigeminal neuralgia and glossopharyngeal neuralgia), (4) pain from tension and vascular changes, and (5) pain from malignant tumors.

PAIN OF DENTAL ORIGIN

Pain of dental origin may be due to pulpal hyperemia, pulpitis, or necrosis. Changes in the dental pulp may be brought about by any of a series of events. Gross physical trauma, microtraumata from malocclusion, proximity of large restorations, frank pulpal exposures with bacterial invasion, and chemical irritants are some of the agents eliciting pulpal changes. Pain from inflammatory changes in the pulp emanates from those branches of the trigeminal nerve within the pulp chamber.[9] Since these contain no proprioceptive fibers, pain at the onset may be difficult to localize. When the noxious stimuli pass through the apical foramen and involve the periodontium, localization and pain to percussion may be noted.

While the pathosis is confined to the dental pulp, pains may be referred from one branch of the trigeminal nerve to another.[9] An important diagnostic feature is that pain will not be referred across the midline.

The opinions or assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

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A 28 year old nurse complained of pain ascribed to toothache in the mandible. Day by day, all the large restorations in the mandibular teeth on one side were removed and replaced by sedative dressings, but the pain continued. A consultant who was called in pointed out a cariously exposed maxillary third molar. This was removed, and the pain ceased.

The first step in making a diagnosis is a careful examination and analysis of clinical signs and symptoms and present oral condition.[1] Acutely exacerbated periodontal disease may simulate pulpitis; but since proprioceptive fibers are involved, the pain is usually localized. Large restorations and deep caries should be painstakingly examined, and a careful history must be taken with regard to possible previous trauma. After the clinical examination, full mouth roentgenograms are indicated, for studying them frequently offers an explanation of the pain.

Most patients with really obscure pain of dental origin will display none of the obvious phenomena. The electric pulp tester furnishes valuable information, since the relative ability of the pulp to react to the electric current denotes in some measure the vitality of the nervous elements within the pulp. The presence or absence of responses to the electric impulse is a reasonably reliable criterion of the condition of the pulp. Tests for thermal response should also be employed. The application of ice or heat to the suspected tooth frequently elicits thermal responses which clearly determine the diagnosis.

Pulp Stones. The literature is replete[14] with instances in which dental pain has been produced by pulp stones, and many of these instances seem well documented. It has been noted that pulp stones are a relatively common roentgenographic demonstration. Thousands of patients are seen every year who have pulp stones, yet few complain. For this reason, any diagnosis based purely on roentgenographic evidence of a pulp stone in a tooth is automatically suspect. Because pulpal calcifications are usually only the observable result of other pulpal changes, it is not believed that any tooth should be condemned simply because of roentgenographic evidence of a pulp stone: some corroborating evidence as to the presence of a valid pathologic condition is necessary. It is only after all other methods of obtaining an adequate diagnosis have failed that consideration should be given to indicting a pulp stone as the cause of the pain.

Impacted Teeth. Many patients live their lives with impacted teeth in various positions in the jaws. These patients are not aware of their defect nor have they any complaint referable to it. For this reason, an impacted tooth does not of itself constitute a pathologic entity. Frequently these teeth grow in such a fashion as to contact the roots or crowns of other

teeth. Subsequent to the exertion of forces of growth, resorption of the teeth concerned becomes apparent,[14] even to the extent that pulpal exposure is produced. While these malpositioned teeth are still capable of erupting, they may cause facial pain. Evaluation of roentgenograms in these cases usually facilitates the diagnosis. In other instances, the partial eruption of such impacted teeth may occur, permitting the operculum to become inflamed. In this instance, the evidence of pericoronitis upon examination should be apparent. There are frequent references in the literature to vague or obscure facial pain being produced by apparently quiescent impacted teeth, but valid instances are rare. Not too much credence should be placed on the roentgenographic "discovery" of an impacted tooth until other possibilities are exhausted.

As previously stated, pain of dental origin can usually be localized by means of careful physical examination, dental roentgenograms, history, and analysis of symptoms—the most important of which is that sense of location caused by involvement of proprioceptive fibers; and since the pulp has no proprioceptive fibers, pulpal pain is frequently difficult to localize. Noyes[13] points out that a blindfolded patient with pulpal exposures in several parts of the dental arch, both maxillary and mandibular, is unable to locate the pain when only the pulp is stimulated. Localization must be made, then, on the basis of the disease present in the pulp.

Variations in Pulpal Responses

1. *Hyperemia.* Hyperemic pulps have undergone vascular changes in response to some noxious stimulation. Any application which tends to further stimulate this pulp induces a pain or hypersensitive response; thus, certain responses to heat, cold, or shock with the electric pulp tester all suggest hypersensitivity in this condition.

2. *Pulpitis.* Pulpitis represents response of the dental pulp to stimuli capable of producing inflammatory changes. As these inflammatory changes progress, they eventually result in necrosis of the pulp. Prior to advanced progressive changes, this pulp responds to stimulation much like the hyperemic pulp. As changes progress, the electric pulp tester may elicit subnormal to negative responses. Heat, in turn, may now increase pain and cold may reduce pain, owing to the alterations in the relative volume of extravascular fluid in response to thermal changes.

3. *Pulpal Necrosis.* A necrotic pulp usually offers no response to the electric pulp tester. There are exceptions in multirooted teeth, in which a portion of the pulp remains vital though the remainder has become

necrotic as the result of loss of its blood supply. Unless some ready escape is available for the products of necrosis, heat produces pain and cold relieves pain because of relative pressure changes.

PAIN OF SINAL ORIGIN

Contrary to the opinion of many, sinuses are not highly susceptible to pain response except for a small area around the natural ostium.[8] Much "sinus trouble" is the result of engorgement of the mucosal covering of the turbinates in the area of the ostium, interpreted as pain in the sinuses. This pain may also be interpreted as toothache, or toothaches as sinusitis, although painful sinuses as the result of drainage from infected teeth are rare. Experiments have shown that the sinuses are capable of withstanding a large amount of both positive and negative pressure with little pain, whereas slight pressure at the ostium produces pain. Conversely, slight swelling of the turbinate mucosa, with involvement of the ostium, may produce pain which is interpreted as toothache or sinusitis.[11]

Diseases of the sinuses commonly seen are: simple mucosal thickenings due to some irritating factor, mucoceles, polypoid hyperplasia, acute pyogenic infections, and, occasionally, cysts of dentigerous, radicular, or developmental origin or dental foreign bodies, iatrogenic in nature. The importance of these conditions to the dentist lies in their differentiation from pain of dental origin and in assisting the patient to obtain the needed care.

Examination of the patient in the dental office should include several maneuvers possible with the equipment generally at hand. Palpation over the facial bones in which sinuses are usually found may elicit pain to pressure. Swellings, particularly over the malar eminence, are not uncommon. If the examination room can be darkened, the diagnostic light on the unit serves to transilluminate the sinuses and to reveal inability to transmit light compatible with mucosal changes. Indirect nasopharyngoscopy with the dental mirror reveals postnasal drainage and inflammation common to these conditions. The anterior nasal cavity and the turbinates may be seen directly by extending the patient's neck and retracting his nostrils. Some estimate of inflammation and swelling can be made.

History taking is important in making a diagnosis of acute sinusitis. Allergy, weather trauma, noxious fumes, and other stimuli have a tendency to produce swelling and vascular changes in the mucosal covering of the turbinates in the area of the sinal ostium. The result may be sinus-like pain which actually originates in the nose and which has no bearing on the sinus itself. Sinusitis is recurrent and frequently

manifests itself in conjunction with upper respiratory infections or activities producing intranasal changes, such as swimming and diving. Tension and vascular cephalalgias, which are also recurrent, produce sinus-like pains owing to the manifestation of sympathetic nervous system symptoms, including swelling of the nasal mucosa.

Roentgenographic examinations in the dental office usually consist of periapical films of the teeth and occlusal films of the maxilla. These roentgenograms are adequate to localize foreign bodies in the antrum

Fig. 1. Dental roentgenograms readily demonstrated the foreign material (dental cement) lodged in the soft tissues (*A*) after cementation of this full mouth reconstruction. They failed, however, to reveal the large dentigerous cyst filling the antrum (*B*) or the presence of the third molar (*C*) in the medial superior wall of the antrum.

or to study the relation of teeth to the antral floor, but they do not offer sufficient area for comparison to make a diagnosis of sinusitis (Fig. 1). Large roentgenograms of the paranasal sinuses can be taken on a dental x-ray unit, provided the proper cassettes are available, and are very valuable in making this diagnosis. In particular the Waters view, which throws the petrous ridge of the temporal bone below the diagnostic field, provides an excellent opportunity for comparison of the two sides and readily reveals clouding and fluid levels.

Lobulations within the sinuses reflecting the shadows of bony compartments are normal in most cases and may be mistaken for cysts. Cysts invading the antra are rarely surrounded by radiopaque bony

walls. Infected teeth whose roots are narrowly separated from the antra can produce infections, but the mere presence of the apparent proximity in the roentgenogram does not constitute a pathologic condition.

A young woman consulted her dentist for restorative dentistry after a pregnancy. She had a history of "sinusitis" for 8 years. The dentist made a diagnosis of radicular cyst of the first molar involving the sinus, on the basis of the lobulations seen in the roentgenogram (Fig. 2). A Waters view (Fig. 3) demonstrated generalized clouding of the antrum. Surgical intervention revealed no direct

Fig. 2. Confluence of radiopaque septal bone within the antrum gives impression of presence of cystic defect. The fact that the lamina dura of the first molar is intact belies this diagnosis.

connection between the teeth and the antrum. The antrum was filled with hyperplastic polypoid tissue, but no cyst was observed. This case demonstrates a situation in which disease of the sinus and dental disease existed concurrently, but were not apparently related. The diagnosis of radicular cyst was founded on roentgenographic evidence which failed to demonstrate the entire situation.

Pain from sinusitis is usually described as low grade, aching, deep, and dull.[15] This pain may increase or decrease with alterations of position of the patient's head. It is frequently referred to other portions of the trigeminal distribution, such as the ear, the temporal region, or the teeth. The posterior molars frequently become tender and feel "long," as may the bicuspids when they are close to the antral floor. Tenderness of more than one tooth to percussion is typical of this situation.

Fig. 3. A Waters view offers opportunity to study comparative density of both antra. This is not possible with any series of dental films.

Pain referred from the nose to the teeth, however, usually involves the anterior maxillary teeth.

PAIN FROM MAJOR TICS

Trigeminal Neuralgia

Trigeminal neuralgia, or tic douloureux, is a disease of unknown cause which affects branches of the sensory portions of the trigeminal nerve. Among causes thought to be exciting are diseases of the teeth and supporting structures. The location of the pain frequently invites consultation with the dentist in the belief that some dental condition is responsible.

This unfortunate condition usually occurs in middle-aged or older people, but may occur in those much younger. It may also occur as either an early or a late manifestation of multiple sclerosis.

Symptoms. The symptoms of trigeminal neuralgia are rather typical and should not be mistaken for pains of dental origin.

1. The pain is usually unilateral and follows the distribution of one division of the fifth cranial nerve. Seldom does it involve both sides of the face, and it does not cross the midline. A second division of the trigeminal nerve may become involved on the same side.

2. A trigger zone is usually present. When touched, this zone causes acute, explosive, paroxysmal pain, agonizing in character. The patient will go to any means to prevent "being triggered," to the extent that he will cease to brush his teeth, eat, or shave. He may have a wooden expression and refuse to talk, preferring to write notes. This trigger zone frequently may be recognized as the peripheral portion of the distribution of a branch of the fifth cranial nerve. Common areas are over the mental foramen, the lower lip, the mucosa over the anterior gingiva or cheek, and over the terminal branches of the infraorbital nerve. Because the pain is seldom triggered in any of the alveolar branches, the teeth rarely seem to be the focus, although they may ache during an attack.

3. The pain is usually described as being superficial, bright, or burning, and as being located on the surface, with deeper aching pains occurring after acute attacks. The patient can usually point to the origin of the pain with a single finger rather than cover the face with the hand and stroke a large general area, but seldom will the sufferer willingly touch the affected area.

4. The pain is also usually described as "shooting," with the course parallel to the line of the lower border of the mandible.[7] The phenomenon is most characteristic and can be regarded as diagnostic when other criteria are present.

Major tic is sometimes confused with other facial pains and with pains associated with the teeth and oral structures.

A 72 year old woman was referred to us for dental evaluation. She had suffered for 20 years with a major facial tic. Early in the disease, her problem had been diagnosed as "pulp stones" and all her teeth had been extracted. When seen, she wore complete upper and lower dentures which caused excruciating pain when removed or replaced, but which were relatively comfortable when worn. Eating, talking, and smiling produced similar pain. No relief was obtained from sphenopalatine ganglion cocainization (through the nose), but immediate transient relief was obtained with a second-division block.

Differentiation. Common errors occur in differentiating between trigeminal neuralgia and the following conditions:

1. *Atypical Facial Pain.* This condition is most difficult to differentiate, the principal point being the nature of the pain. In atypical neuralgia the pain is burning, constant, and deep, with periods of remission and increase. It does not necessarily follow a typical distribution. Such pain may also be caused by tumors involving the gasserian ganglion, but will then be accompanied by such neurologic signs as paresthesia, motor weakness, or loss of the corneal reflex.

2. *Histamine Headache.* This condition may be differentiated by several means. The nature of the pain is different in that the histamine headache occurs slowly, sometimes with a premonitory aura, persists

for an hour or more, is dull and burning, occurs while the patient is at rest, is accompanied by sympathetic symptoms, and does not follow the distribution of any branch of the fifth cranial nerve. Trigeminal neuralgia, on the other hand, is lancinating, explosive, paroxysmal, recurrent, rarely accompanied by sympathetic symptoms, follows peripheral distribution with some accuracy, and seldom awakens the patient at night unless the trigger zone is touched—an incident the patient rapidly learns to avoid.

3. *Toothache, Oral Ulcers, and Acute Periodontal Disease.* In trigeminal neuralgia there is an absence of objective signs or symptoms such as caries, periapical lesions, percussive tenderness, abnormal thermal responses, electric pulp tester evidence, or any of the cardinal criteria of pulpal involvement. Although the mouth may be very dirty, with attempts to rectify this condition being met with pain symptoms, treatment will fail to alleviate the pain.

Treatment. It has been said that all treatment of tic has one common factor: manipulation of a portion of the fifth cranial nerve. The only procedures known to produce total permanent relief are neurosurgical operations in which sectioning or decompression of a sensory portion of the nerve is performed. There are several such procedures advocated, but no effort will be made to describe them in this article. There are, however, several temporizing methods which bring about relief for varying periods, and which aid in diagnosis.

Authors have described varying degrees of success employing vitamins, particularly B_1 and B_{12}, and alterations in the nutritional status of the patient. Usually, benefits have been transient, undependable, and nebulous. Inhalation of trilene has produced relief, but is followed by remission. This does not militate against the employment of these means to guide the patient into thinking in terms of proper nutrition, a factor frequently neglected because of the pain.

Injection of a local anesthetic is most effective in the hands of the dentist, and will produce relief for the duration of the action of the anesthetic. In some instances the relief is prolonged.

A 54 year old woman was referred for treatment, by injection, of trigeminal nerve tic which triggered in the area of the mental foramen. A mandibular block was established with a local anesthetic. She remained free of symptoms for 18 days, after which symptoms returned in reduced degree for 3 months. Full symptoms again returned and were not alleviated beyond the duration of anesthesia with subsequent blocks. This pain-free experience encouraged her to accept peripheral avulsion of the mental nerve and third-division alcohol block, which has kept her comfortable for several months.

If this method is employed, the block technique at one of the foramina should be used rather than infiltration of the area.

Absolute alcohol, 0.5 to 1.0 cc., may be injected at the supraorbital

infraorbital, mental, or mandibular foramen or at the foramen ovale or foramen rotundum. This procedure, if properly executed, produces anesthesia of the distribution of the division or branch injected for a protracted period. Three years is about the maximum expected, but the period is usually much shorter. If the more peripheral sites are employed, the duration is seldom more than a few months.

Peripheral section or avulsion of branches of the trigeminal nerve is easily accomplished by surgical exposure. The inferior alveolar branch, mental branch, and infraorbital branch are readily reached. The lingual nerve, although easily exposed, is seldom affected. Section or avulsion of a portion of these nerves produces relief, provided the pain is confined to this distribution. Usually the pain recurs higher in the same division, and consequently, little is accomplished. The nerves regenerate in time, and with the return of sensation, pain also returns. Failure to achieve even temporary relief in these procedures is strongly suggestive of error in diagnosis, and pain on a vascular basis is suggested.

These procedures are all within the purview of the capable dentist, and are justified and beneficial because they not only offer the patient temporary relief from pain but also give him an opportunity to evaluate the numbness so immutably a part of the neurosurgical procedure of retrogasserian section. Some patients find they prefer repeated injections or pain to lifelong numbness. Others welcome surgical intervention at the earliest possible time. The patient who has received these temporizing measures is in an excellent position to decide intelligently for himself what is best for him.

Needless to say, even the most fundamental dental operations on this patient may require prior anesthesia.

Glossopharyngeal Neuralgia

Glossopharyngeal neuralgia is an uncommon disease.[2,10] The pain, similar to that of trigeminal neuralgia, is paroxysmal, unilateral, excruciating and of short duration, and usually triggered by eating, chewing, swallowing, or speaking. It may be associated with burning or dryness of the throat, extends from the root of the tongue down the throat, and is referred to the ear and neck. It is said to be accompanied sometimes by pain like that caused by the bursting of an eardrum.

It may be difficult to differentiate between this disease and trigeminal neuralgia, temporomandibular joint disturbance, or nervus intermedius tic. In some instances it may resemble one of the manifestations caused by tension and vascular changes. Primary points of differentiation are:

1. The pain follows the distribution of the glossopharyngeal nerve, although it may not encompass the entire course.
2. It is unilateral.
3. The manifestations of pain are similar to fifth cranial nerve tic, but do not involve that nerve.
4. Cocainization of the tonsillar fossa will bring about temporary relief.

PAIN FROM TENSION AND VASCULAR CHANGES

This kind of pain is discussed in the literature under many headings; and, indeed, there are major differences in the symptoms and course of the various conditions. Common terms employed to describe such conditions are Horton's headache, histamine cephalalgia, Sluder's neuralgia, sphenopalatine ganglion neuralgia, migraine, migraine equivalent, atypical facial pain, minor tic, or minor neuralgia, to name a few. Although the exact nature of any of these conditions is not clear, the fundamental change which produces the pain is an alteration of the caliber of arteries which are branches of the internal or external carotid arteries.

Some authors point out that tensions produce vasoconstriction, muscular contraction, and muscular ischemia in the vessel walls which eventually lapse in the failure phase of the general adaptation mechanism, with accompanying vasodilatation and hyperemia of the vasa vasorum. Traction accompanies this vascular change, and pain is referred to some spot in the head or on the face. Migraine is explained in this fashion—the prodromal symptoms and scotomata occurring in the vasoconstriction and ischemia stage, headache in the vasodilatation phase, and residual low grade headache and nausea during the subsequent cerebral edema. Interruption of the process during the prodromal phase with vasopressor drugs, such as ergotamine tartrate, may thus abort an attack.[3,6]

Others suggest that the eventual vasodilatation is the result of the formation of histamine[4] as a degradation product of the amino acid histidine. This explanation seems well founded on the basis of the production of experimental headaches in susceptible persons by the administration of test doses of histamine, and the eventual desensitization of some subjects and relief of their pain by fractional injections of this drug.[5]

Moench[10] extensively documents the pain-sensitive structures of the head, and indicates the portion of the head and face which hurts when noxious stimuli are applied to certain arteries and other structures of the head. He also points out that "blood volume is increased by nitrites, histamine, nitroglycerin and caffeine withdrawal, and is de-

creased in migraine and during menstruation and relaxation."[10] Thus headaches may be induced with either increased or decreased blood volume when there are no compensatory changes in the tone of the vessel walls and some traction occurs.[16] It seems clear, then, that in spite of the exciting cause, the pain results from "inflammation, traction, displacement and distention of the pain-sensitive structures. As a source of pain, the cranial vascular structures far outweigh in number and distribution all others."[12]

The dentist renders great service when he is able to recognize these complaints for what they are, and to eliminate any oral condition as a possible cause before referring patients to other specialists for treatment. Such patients frequently visit the dentist, the ophthalmologist, or the rhinologist in the mistaken belief that they suffer from some malady of the teeth, eyes, or nose. Since cocainization of the nasal mucosa (principally the sphenopalatine ganglion), anesthesia of some branches of the trigeminal nerve, or the simple stimulation of examination and maneuver by the practitioner produces relief in certain of these conditions, the examiner is led to believe that he is on the right track, only to be disillusioned by the return of the pain after operation or treatment.

A 34 year old man consulted us for the removal of a maxillary cuspid which, he said, "ached." The tooth was normal in all respects, as was his entire mandibular dentition. His maxillary dentition was surgically absent except for the six maxillary anterior teeth. He described a rather typical vascular cephalalgia which had caused pain in his teeth for several years, first on one side, then on the other. During these years, he had had his teeth removed, one by one, first on one side, then on the other, each time with temporary relief of his symptoms. Neurologic examination revealed no pathologic condition. He is currently on good medical management with Cafergot and wears a maxillary partial denture over his "aching" teeth. Histamine desensitization is being investigated.

Differentiation. Although no attempt will be made in this article to differentiate any of the various conditions produced by vascular changes from each other, some differentiation may be made between these conditions and pain of genuine dental origin.

1. The pain is usually dull, deep, intense, and pulsating; centering deep, frequently behind the eye, temple, or occiput.

2. The patient can usually outline an area over the face where the pain starts, usually over the eye, side of the nose, temple, or occiput.

3. The patient usually testifies that the pain "spreads" or is referred to other spots. As the headache matures, a tooth, frequently but not necessarily a molar, may ache and feel long.

4. The pain frequently occurs while the patient is at rest—often an hour or two after retiring, while sitting, during week ends, or on days off.

5. The pain is frequently accompanied by sympathetic symptoms, such as lacrimation, conjuctival injection, and swelling of the nasal mucosa. The mucosal swelling in the turbinates may be the cause of the secondary pain referred to the sinuses or teeth. In some instances there is nausea.

6. There may be a premonitory aura, and the patient may be able to "feel one coming on." When so disturbed, the patient may be able to abort or reduce the headache with Gynergen, Cafergot, or coffee; or by sitting, standing, moving around, or smoking. Aspirin or barbiturates seldom aid, although the activity of arising from bed to obtain the drug may be sufficient to reduce the pain.

7. The patient frequently associates the onset of the trouble with some other state, such as changes in the weather, ingestion of alcohol, particularly beer, contact with certain materials or foods, or increases in stress at home or office.

8. There may be accompanying myalgias, such as soreness and tension of the muscles of mastication or the posterior neck muscles. Firm nodular swellings may appear in the muscles, especially in the posterior neck.

9. Pressure on a carotid artery, at the bifurcation, may alter the pain.

10. Complaints referable to dental structures, eye, or sinuses may usually be differentiated as secondary or subsequent to the original onset of pain. Usually the pain persists for not more than an hour or two, but the dental or sinal discomfort continues for the duration of the sympathetic nervous system changes.

These conditions do not resemble the major tics in that the pain is different in character, being deep and aching rather than superficial and bright. There is no trigger zone. The area affected does not faithfully follow any known distribution of divisions of the trigeminal nerve; it follows, rather, the distribution of sensitive responses of certain branches of the carotid arteries. The pain is usually unilateral, occurs at rest, is persistent for varying lengths of time, and then disappears. The pain, furthermore, may seem to "build"—or prodromal symptoms may be present—rather than have a sudden, shooting onset, as in tic.

Management. Management is usually by means of ergotamine drugs, histamine desensitization, anesthetic injections in pain pathways, tranquilizing drugs, and psychotherapy, and is determined on the basis of an adequate physical and neurologic examination. Obviously these are not problems which lend themselves to management in the dental office. The dentist can and should, however, take a thorough history, make a good clinical examination, take necessary roentgenograms, and, if indicated, make selective diagnostic anesthetic injections to

satisfy himself that the pain is of a vascular nature rather than a toothache or pain from the temporomandibular joint.

A 38 year old nurse had been treated extensively for temporomandibular joint pain by means of equilibration, alteration of vertical dimension, and fabrication of very high quality appliances for the restoration of centric occlusion and relation. She experienced intermittent remissions and exacerbations of her pain, described as acute, boring, and radiating, starting at the temporomandibular joint —first one side, then the other, and sometimes bilaterally—and reflecting backward and downward to the base of the occiput. Procaine injections into the joint space produced temporary relief, as did hydrocortisone. A history revealed that she was pregnant, separated from her husband by the exigencies of the service, and about to be separated from the service—which would require her to establish her first home. Physical examination disclosed a firm nodular swelling in the posterior neck muscles, probably the semispinalis. Injection of an anesthetic at its insertion relieved all pain. In spite of the evidence, she declined further investigation on the basis of tension and vascular changes.

PAIN FROM MALIGNANT TUMORS

Pain from malignant tumors is usually a late sign. The most common malignant oral neoplasm is squamous carcinoma. This disease and most other malignant tumors of epithelial origin do not give rise to pain until they become secondarily infected or impinge on some vital structure, which in turn gives rise to pain. It becomes apparent that the primary responsibility of the dentist is to detect the malignancy of a tumor before pain occurs. It is regrettable that this is not always possible.

It has been stated that most oral tumors give rise to pain only in the later stages; therefore, most painful lesions are apparent to the examining eye and finger. Any lesion which is present for one week or more, painful or not, and which has no clear-cut physical or historical reason for existence is automatically suspect. Firmness, induration of the base, exophytic characteristics, ulceration, the presence of nodes—all add fuel to the flame of suspicion. Prompt biopsy with histopathologic examination is the only rational method of securing a diagnosis. Even as Davy Crockett was, in legend, able to "grin a bear to death," prolonged observation of a lesion with a high index of suspicion may mean that you have "watched your patient to death."

Situations of this nature are usually clear cut, and a reliable histopathologic diagnosis points out the path of treatment. Primary tumors of mesenchyme, metastatic tumors, and neoplasms which refer pain to the facial regions are a more difficult problem.

Signs and Symptoms. Primary in the list of attributes of malignant lesions is their ability to invade all types of tissue; thus, in addition to pain, other signs and symptoms usually appear.

1. There may be motor as well as sensory involvement.
2. The sensory involvement may be first pain, then paresthesia.
3. There is frequently a swelling.
4. There is frequently involvement of the regional lymph nodes.
5. There is frequently evidence of osseous involvement.
6. There may be evidence of resorption of tooth roots when they are in the area of the tumor.
7. Teeth involved in an invading tumor become painful, discolored, and subsequently nonvital. Pulpal pain may disappear and be supplanted by periodontal pain.

Fig. 4. Note the erosion of the distal root of the mandibular first molar involved in the tumor.

These signs and symptoms are only suggestive of a malignant growth and do not conclusively determine the diagnosis. Many other diseases can cause one or more of the conditions suggested. Again, biopsy with histopathologic examination is the only reliable method of making a diagnosis.

Pain has been observed in the oral and facial regions from ameloblastoma, primary and metastatic epidermoid carcinoma, metastatic prostate tumor, metastatic neuroblastoma, leukemia, metastatic transitional cell carcinoma, cylindroma, tumors of the central nervous system, and sarcomas; but in no instance was pain the only symptom.

Although it is not intended to discuss the roentgenographic characteristics of various malignant tumors primary in or invading bone,

Figure 4 offers an example of what may be revealed when investigating the original clue of pain.

A 12 year old boy was brought for consultation regarding pain from a lesion of the gingiva over the area where the mandibular second molar was expected to erupt. He had been seen 4 months previously by his family dentist, who had recommended that he employ hot saline soaks until the tooth erupted. The roentgenographic evidence is clear in the figure. The tumor was an ameloblastoma. The thick cortical wall suggests a cyst. There was bulging of the plates, which is compatible with a cyst. There was paresthesia of the lip, which may well occur in a cystic lesion. The presence of a tooth in the tumor immediately brings

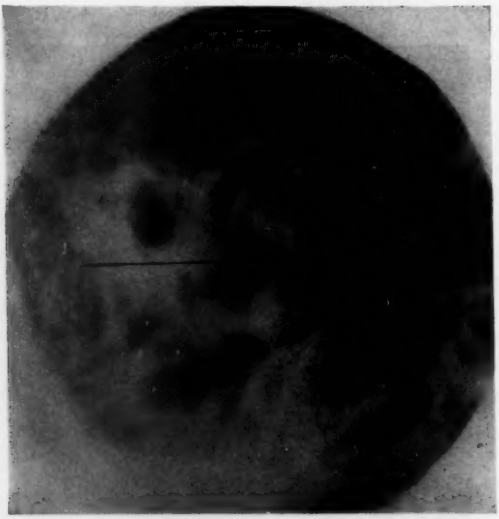

Fig. 5. Subsequent to demonstration of this metastatic osseous lesion, other distant metastatic lesions were disclosed.

to mind a dentigerous cyst. The tumor was removed, with a diagnosis of ameloblastoma—confirmed on frozen section—on the basis of the erosion and nonvitality of the first molar and the presence of a painful, exophytic, ulcerated growth on the gingiva.

Figure 5 demonstrates a radiolucent area in the condyloid process of the mandible. The patient had been treated for some time for pain from a temporomandibular joint disorder by means of equilibration. The history of bronchogenic carcinoma plus the roentgenographic observation of osseous radiolucency immediately offers the diagnosis of metastatic tumor.

Thus it becomes apparent that nothing short of histopathologic examination can confirm the diagnosis of malignant tumor, of which pain is but one of the many signs and symptoms.

It is mandatory, therefore, to consider, in detail, the history, clinical examination, and various physical signs and symptoms as well as the roentgenogram before suggesting the diagnosis of malignant tumor.

CONCLUSIONS

If it is possible to conclude anything from a discussion of this type, it must be apparent that good diagnosis is the same thing as good police work. There may be detectives who, like Sherlock Holmes, can make brilliant armchair deductions. These people exist mainly in fiction. There may exist in medicine the experts, portrayed in the movies, who make a diagnosis of ruptured spleen and treat the patient in a roadside ditch. For most humans, whether detecting crime or disease, the problem resolves itself to good legwork.

Good diagnosis results from the employment of education, intelligence, judgment, the God-given senses, and the man-made diagnostic aids. The use of these ingredients takes time. It also requires effort—physical and intellectual. Anything less than full scale employment of all the facilities at one's disposal is to shirk one's essential responsibility to mankind.

The practitioner who operates on meager evidence, or who dismisses a knotty problem by casting it at the wastebasket labeled "neurotic," "sinus trouble," "pulp stones," or "impactions" without real evidence for doing so, practices empirically and does his patient great injustice.

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Pericoronitis

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Pericoronitis is inflammation of the tissues surrounding the crown of a tooth. Clinically this is nearly always associated with incomplete eruption. It is seen most often in the mandibular third molar area in the young adult. However, it may be seen with other less frequently occurring impacted teeth. It can occur at any age and it is not unusual to see this condition in patients in middle life who are apparently edentulous and are wearing artificial dentures. Probably the majority of cases of pericoronitis are of trivial nature, causing the patient little discomfort, so that they are rarely presented to the dentist for diagnosis and treatment. On the other hand, acute pericoronitis causes pain and dysfunction which may be severe enough to render the patient acutely ill.

PATHOLOGY

Since the mandibular third molar area is the one most frequently involved, it serves as the best example for study of the underlying pathology. The same principles apply in other regions. Just before eruption, the crown of a tooth is enclosed in its follicle or crypt. There is a space, or potential space, between the crown of the tooth and the follicle. The part of the follicle over the occlusal surface is covered only by the gingiva. In nearly every case of pericoronitis this layer of tissue has lost its continuity at some point, so that mouth fluids and bacteria gain entrance to the space between the crown of the tooth and the follicle. Conditions for the proliferation of pathogenic microorganisms are ideal and in this way an inflammatory process begins (see Fig. 1).

Undoubtedly a variety of factors influence whether or not the

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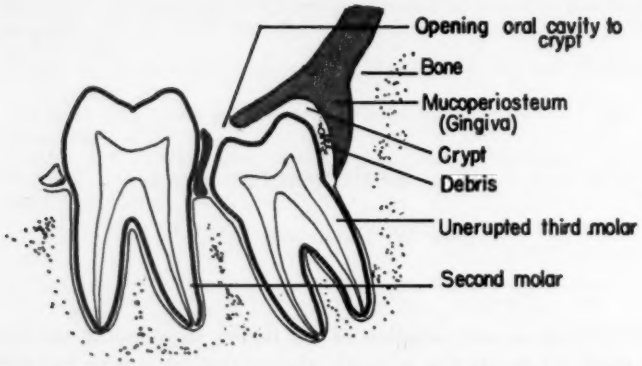

Fig. 1. Section through the mandibular molar area. Conditions favorable for pericoronitis.

process begins at all, or, having begun, affect its severity. The resistance of the individual is probably a very important factor. The virulence of the infecting organisms must be considered. Trauma of the gingival tissue by a tooth in the opposing jaw operates in a number of instances. Finally, accumulation of food debris in the pericoronal space of the follicle predisposes to onset of the inflammation.

SYMPTOMS AND DIAGNOSIS

It is essential to remember that from case to case the inflammatory process varies greatly in severity and extent. These variations determine the symptoms which are evident in any individual case. Of these symptoms, pain in some degree is present in every clinical case. It tends to be constant rather than intermittent in character. It is not aggravated by heat or cold as is the pain of dental pulpitis. Palpation over the crown of the unerupted tooth elicits tenderness. Presence of an unerupted tooth may be evident or may require roentgenographic confirmation. These two findings supported by a suggestive history are usually sufficient to establish the diagnosis.

The history will usually describe unilateral pain although bilateral pain by no means excludes this diagnosis. Pericoronitis may occur bilaterally. The pain is often referred to the ear, sometimes to the neck on the affected side. It is likely to be of recent onset. It may or may not have been preceded by one or more similar episodes.

Other findings are not always present, but when they are, they serve to reinforce the diagnosis. When the inflammatory response is

such that a purulent exudate is produced, it can be seen on inspection or expressed during palpation. Abscesses will be discussed later in this article. While not evident in every case, the aperture into the crypt may often be seen and inspection may reveal the debris within it. This is especially true when most of the tooth has erupted and only the so-called operculum over its distal portion is involved in the inflammatory process. In some cases hyperemia of the inflamed zone of the soft tissues may be prominent and readily observed.

When the inflammation is not limited to the tissues immediately adjacent to the tooth, the patient is prone to have either or both of two additional complaints: (1) Spreading infection which involves those muscles in the masticator space, particularly the masseter and the internal pterygoid, will cause trismus. (2) Inflammation progressing to the medial side of the ramus of the mandible past the pterygomandibular raphe affects the superior constrictor of the pharynx and will cause swallowing to be painful. On occasion both the trismus and the dysphagia are severe. Conversely, the presence and severity of these complaints are useful in making a rough estimate of the extent of the infection. This will have bearing on the therapy selected.

Occasionally one will see generalized fusospirochetal gingivitis (Vincent's angina) associated with pericoronitis. Here it is difficult to determine which areas are involved first. Chronic pericoronitis can cause repeated episodes of gingivitis by serving as a reservoir for reinfection. On the other hand, pericoronitis may first occur during an attack of gingivitis which was so mild as to have been disregarded by the patient until the pericoronitis causes him to seek treatment.

In all cases it is of utmost importance to take a medical history. Conditions favorable for development of pericoronitis may exist many months during health, without clinical signs of the infection becoming evident. Only when the patient's health is impaired will the infection develop. The impairment in health may range all the way from the onset of a severe fatal disease, such as leukemia, to relatively mild conditions which are readily improved. Poor general health is not a factor in every case by any means. The point is that it should never be overlooked.

There are two types of patients met so frequently that they deserve special mention. The first are seemingly healthy young adults, often living away from home, who are getting inadequate nutrition from short order meals in public eating places with less than ideal sanitary standards. They are careless about oral hygiene and adequate rest. The second are women with iron deficiency anemia. Both of these conditions may provide the background for pericoronitis.

TREATMENT

The principles of treatment are three: (1) correction of poor general health where indicated, (2) suppression of the inflammatory process if acute, and (3) correction of the anatomic defect predisposing to pericoronitis. The art of treatment lies in adjusting these principles to the individual case. Let us consider them.

Correction of Systemic Factors

Obviously, a medical history, either brief or detailed as the occasion warrants, is required in every case. When systemic disease plays a role, this must be considered during therapy. If the patient is not under medical care, it should be obtained for him by consultation. Disregarding this principle invites treatment failures and complications.

Suppression of the Inflammatory Process

In minimal cases, infection can be suppressed by very conservative measures. These revolve around the concept of starving out the bacteria by improvement of oral hygiene. Where an accessible space or sulcus exists between the tooth and soft tissues, it should be cleansed by irrigation. This is best accomplished by using a 5 or 10 cc. glass syringe fitted with a 20 gauge blunt needle or irrigating cannula. The nature of the irrigating solution is not important provided it is not unduly irritating or caustic. I am convinced that warm sterile water would equal the effectiveness of other solutions used. Patients expect a medication so I bow to convention and use a flavored mouthwash. The patient should be instructed to augment this by frequent use of a hot mouthwash at home; every hour or two while awake is suggested. After irrigation the area is dried and an antiseptic is flowed into the sulcus with a dripping wet applicator. Here again the choice of antiseptic is not critical. Tincture of iodine is effective in my experience.

Antibiotic Therapy. In those cases in which the infection is not limited to a small area but has involved deep as well as superficial tissues, the above methods alone will often not produce a response, or the response may be very slow. In other cases trismus may be so severe as to render access for treatment difficult. Finally, the patient may be acutely ill with cellulitis secondary to the pericoronitis. In all of these cases an antibiotic administered systemically is indicated. I am well aware of the disadvantages of promiscuous use of antibiotics. Nevertheless, their use is justified in these cases for several reasons. Without antibiotics many cases become progressively worse. With antibiotics the incidence of complications after the subsequent sur-

gical corrections is markedly reduced. Lastly, these are bacterial infections which will respond to a short course of antibiotic therapy; use of antibiotics here is in contrast to less justifiable administration for virus infections and non-specific conditions over long periods of time.

A complete discussion of antibiotic therapy is not intended here. Briefly, the patient should be questioned specifically about allergic sensitivity to previously administered antibiotics. Dosage should be adequate, insufficient therapeutic levels avoided. Procaine penicillin 300,000 units intramuscularly daily, oral penicillin 1,000,000 units daily in four divided doses, oxytetracycline or erythromycin 1.0 gram daily in four divided doses have all been effective. Response is often evident in 2 to 3 days.

Supportive Care. When cellulitis associated with pericoronitis has made the patient acutely ill, more attention must be given to general supportive care. In a few severe cases hospitalization may even be required. Trismus and difficulty in swallowing can cause a decreased oral intake. When fluid intake has fallen behind output and caused dehydration, attention must be given to increasing fluid intake. Elaborate measures are not often needed. The importance of drinking enough fluids is explained to the patient, and he is given a specific goal, usually 3 quarts of nourishing liquids daily. Medication for relief of pain is provided when required. Oral medication with codeine sulfate 30 mg. every 4 hours as needed is convenient and usually effective. The more comfortable patient will be more cooperative about fluid intake.

Drainage of Abscess. While it does not occur frequently, a pericoronal infection may produce an abscess, and when such localized collections of pus form they should be drained. This should be done as soon as the examiner is able to palpate a fluctuant swelling. General anesthesia should be used, with the incision being made intraorally or extraorally, depending on where the fluctuation presents itself. Drains are advisable to maintain drainage where any sizeable amount of pus is encountered. Small amounts of pus draining or expressed from the gingiva about an unerupted tooth, but without fluctuation, do not require incision and drainage.

Extraction of Opposing Tooth. When a tooth in the opposing jaw is traumatizing the soft tissues and contributing to pericoronitis, it may be extracted to aid in overcoming the acute stage of the infection. This is advisable when such a tooth is not essential to the dentition. The classic example is a maxillary third molar when a mandibular third molar on the same side must be removed later. It may be quite proper to do this while the pericoronitis is acute, provided it has not extended to this region also.

It may be well to mention at this point that the simplest method which will give results is the best. Complicated therapy with multiple procedures should be applied only when required. Obviously, to cover management completely, measures which are required only in the infrequently seen severe case must still be discussed. This does not imply that such measures should be applied in every case. Therapy, like the best clothing, should be custom-made, not mass produced.

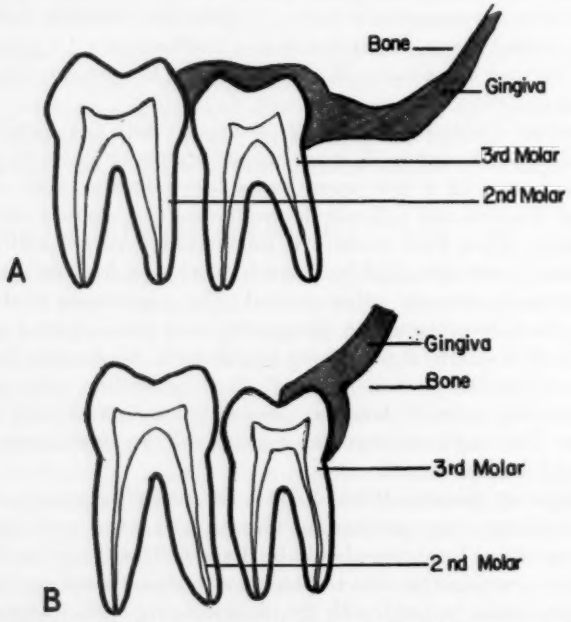

Fig. 2. *A*, Favorable for excision of gingiva and surgical exposure. *B*, Unfavorable for surgical exposure.

Correction of Predisposing Anatomic Defects

After attention has been given to suppression of any acute infection and to the state of the patient's health, we may then proceed to correct the underlying anatomic situation which has been responsible for the pericoronitis. This is done either by surgical excision of the gingival tissue over the partially erupted tooth or by removing the tooth itself.

Gingivectomy. Excision of the gingival tissue is successful in a rather small number of instances; the majority of cases require removal of the offending tooth to prevent recurrence. Gingivectomy should be done only in those cases in which the involved tooth can be readily

exposed to the normal cervical line, or at least quite close to it. Figure 2*A* depicts an ideal case. Note particularly the low level of bone to the distal of the tooth. Figure 2*B* shows a high level of bone to the distal of the tooth. Here gingivectomy would be a failure. Exposure of the occlusal surface alone permits reinfection to occur in the distal gingival sulcus, which remains deep and relatively inaccessable. Many times this is associated with gingival hypertrophy and the occlusal surface once again becomes partially covered with soft tissue. It bears repeating that extensive gingivectomy during acute pericoronitis invites cellulitis in a vulnerable area. Excision of tissue can be done with the scalpel or electrocautery. The cautery makes the procedure much simpler and is preferred. Postoperative pain may be considerable and medication should be provided to control it when necessary.

Removal of the Involved Tooth. Removal of the offending tooth requires attention to those principles which apply to the removal of impacted teeth and partially erupted teeth elsewhere. In addition, some cases will require careful consideration as to just when this may be done. In minimal pericoronitis when the patient's health is good, it is often possible to proceed immediately with removal of the offending tooth provided an adequate amount of a suitable antibiotic is administered. This might be as little as one intramuscular dose of procaine penicillin 300,000 units given at the time of the procedure, or 250 mg. of erythromycin, tetracycline, or oxytetracycline given every 6 hours for six doses. Dosage should be increased at the operator's discretion. When the inflammatory process is more severe, when the patient is in less than good health, or when removal of the tooth may be expected to be difficult, it is important to defer removal of the tooth until the infection has subsided to an appreciable degree.

General anesthesia is usually the method of choice. Injection of local anesthetic solutions close to inflamed tissues runs the risk of dissemination of the infection. Where it must be used, one should be certain that all inflammation has subsided. Antibiotics incorporated in the anesthetic solution do not provide an adequate safeguard. Even worse, they may temporarily mask symptoms and the resultant infection tends to be chronic and resistant to further treatment by antibiotics.

RESULTS OF IMPROPER MANAGEMENT

Improper management, as has already been pointed out, invites resurgence of the inflammatory process due to the trauma of surgical intervention, or extension of the infection due to mechanical dissemination during injection or instrumentation. This risk is always greater in the patient with poor resistance. When the bone itself is involved

an osteomyelitis results. Soft tissue extension of infection is more common and depends on the region affected. In the maxilla, infection may spread to the infratemporal fossa. In the mandibular third molar area there are two common routes of extension: (1) The post-injection infection involves the masticator space medial to the ramus of the mandible; extreme trismus is the usual result. (2) In other cases the infection is prone to extend beneath the tongue, above or below the mylohyoid muscle, and may progress into Ludwig's angina. Both routes may also involve the lateral pharyngeal space or, less commonly, the submandibular space. Cellulitis and abscess of these potential fascial spaces are by no means trivial illnesses. They may require hospitalization, with incision and drainage, and while antibiotics have markedly reduced their incidence and mortality, no conscientious practitioner wishes to think that carelessness on his part might have contributed to such an unfortunate sequence of events.

SUMMARY

Successful management of acute pericoronitis requires establishment of a correct diagnosis. An evaluation of the patient's health should be included. Therapy consists first of measures to control infection and then surgical correction of the underlying defect. Judgment in adjusting therapy to the individual case is the most important factor, and perhaps the most difficult to acquire.

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The Prevention of Instrument Accidents in Oral Operations

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As the title of this paper implies, instrument accidents, unintentional and unfortunate, occur in dentistry—in all its branches—and it is of great importance not only that such accidents be prevented but that their repetition be avoided. It goes without saying that no branch of medicine is without hazard, and the law suit which may follow an accident creates a very unhappy situation which no one wants, so the keynote is "prevention."

PREOPERATIVE PREVENTIVE MEASURES

As an aid in undertaking the care of a patient it is wise for the dentist to have in mind some fundamental principles of preoperative prevention of instrument accidents in oral procedures:

1. No oral operation should be attempted when the operator is not certain of carrying it out to completion with a minimum of trauma and time.
2. Adequate roentgenograms must be available, and preferably they should be those taken by the operator.
3. A satisfactory history of the patient may reveal the state of health, which may have a bearing on the oral condition.
4. Laboratory findings should be available in certain cases.
5. A physician's report of examination of the patient also should be available when important.
6. The dentist should see that not only has the operating room adequate illumination, but the field of operation is well lighted—even to wearing a head light.

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7. Anesthesia must be carefully selected for the patient and the procedure.

8. Careful visual and clinical preoperative examination of the patient helps to determine the patient's attitude toward the anticipated operation, and psychic manifestations may be revealed.

9. Gain the patient's confidence by the attitude of your approach to the problem. Acquaint the patient with your diagnosis and intended treatment so that your intentions are understood.

10. The patient should be comfortably seated in the dental chair, with the head and mouth in such a position that the work can be done without stress.

11. Never hesitate to refer a patient to another dentist or specialist.

To a degree, accidents causing instrument injuries in oral surgery are comparable to those in other branches of dentistry. Because I am most familiar with the specialty of oral surgery, this paper will deal mainly with oral surgical incidents.

SOFT TISSUE INJURIES

Too often instrument injuries involve soft tissues. There can be crushing, slipping, cutting or abrasions, all of which result in unnecessary bleeding. It is possible that an injury may not cause much bleeding at the time of the accident, but bleeding may appear later and require clamping, suturing or electrocoagulation. Synchronized hand control and dexterity minimize this danger, so the operator must strive in all procedures to maintain steadiness and adequate control.

It is easy to cut a lip or the tongue with an unguarded scalpel when the tissues are not protected by retractors or fingers.

The unintentional and accidental piercing of the tongue or cheek by suture needles is common, and a sore spot with or without infection may follow.

Grasping of bleeders with hemostats without a definite and controlled application of the instrument to the blood vessel may cause surrounding healthy tissues to be injured unnecessarily.

In general anesthesia cases the use of the crushing type of flat-bladed tongue forceps to pull the tongue forward will cause more injury to the tongue than a one-prong tongue forceps, properly placed through the tongue. Very often all that is needed to pull or move the tongue forward is gauze held with the fingers.

Ratchet-type mouth props may crush the lip or tongue unless care is taken to free them before forcing the mouth open. Ratchet force may also loosen healthy teeth and sometimes remove them from their sockets.

Rubber mouth props may slip, causing tooth, tongue or cheek injury.

Abrasions of the soft and hard palate, including the uvula, occur by careless instrumentation, and the patient suffers a very sore throat for a week or more before healing.

Unnecessary curettage of either healthy or diseased tissue is deplorable. A definite and determined stroke with a definite purpose should be substituted for the nervous and repeated strokes of any instrument.

Probing a duct with force when resistance is encountered, or the use of too large a probe after entering the meatus, unquestionably causes injury to healthy tissue.

The lingual soft tissues should be protected at all times from instrument injury, particularly from drills, wires and periosteotomes.

Gigli saws used in cutting bone can badly injure soft tissues when improperly protected.

Blunt-pointed tissue retractors used in the surgical retraction of flaps are less likely to injure tissues than the pointed type.

Aspirator tips should be examined and kept blunt and smooth so that no abrasion to soft tissue will occur in aspiration. The throat, soft palate and uvula are easily injured by such instrumentation.

Accidental or deliberate severing of any nerve can be prevented by the exercise of great care by the operator. For example, in surgery of retained roots or cystic areas in the apical region of the mandibular bicuspids, cutting by buccal approach should be avoided. The occlusal approach is the one of choice—down through the socket or sockets, retracting the mucosa downward and buccally from the teeth but not sufficiently far to injure the mental nerve.

In major oral surgery, as in excision of the parotid gland, a condylectomy or reduction of fractures at the neck of the condyle, the accidental severing of one or more branches of the facial nerve may be avoided by the use of a sterile faradic electrode to stimulate the distal segment of the nerve. In this way the nerve may be differentiated from other tissues, e.g., small blood vessels. If it is accidentally severed because of failure to recognize it as nerve structure, permanent facial paralysis will result.

Slipping can sever the lingual nerve and cause a temporary, and even permanent, lingual nerve and tongue anesthesia.

Although chemotherapy now gives us confidence that we can control infection we dreaded years ago, nevertheless a surgeon must always be alert to the possibility of instrument injury carrying infection by slipping, such as with elevators into the submaxillary fossa. Infection implanted in that way may extend into the parapharyngeal space

and then down the "Lincoln Highway" of the neck to the carotid space, thereby causing a Ludwig's angina.

The same possibility exists in the case of a cavernous sinus thrombosis, inasmuch as infection from maxillary teeth may travel by two routes to the cavernous sinus. One route of travel is by way of infection passing upward through the angular and ophthalmic veins, which are without valves to the orbit, and thence through the various foramina and fissures directly to the cavernous sinus, or infection of the

Fig. 1. In the extraction of several anterior mandibular teeth, and an alveoplasty, the muscles attached to the genial tubercle were accidentally detached and the patient could not draw the tongue back into her mouth. Surgery corrected the condition.

pterygoid plexus region may travel directly upward to the cavernous sinus. The deep facial and the transverse facial veins may carry infection from the pterygoid plexus to the angular vein, or vice versa to the pterygoid plexus.

The pushing of an anesthesia needle through an infected area may implant bacteria into healthy tissue, possibly causing a secondary abscess. To prevent such an incident, general anesthesia should be used unless anesthesia can be achieved without injecting through the inflammatory area.

Delicate and careful dissection must be carried out in the enucleation of a large maxillary cyst where it extends to contact the antral floor, as the antral mucosa may be perforated and in this way un-

necessary infection of the antrum with bacteria from the cyst or the oral flora may ensue.

Too extensive retraction with periosteotomes may detach muscle to a serious degree. One case of slipping resulted in detachment of the geniohyoid and genioglossus muscles from the genial tubercle region, with serious tongue protrusion requiring major surgery to repair (Fig. 1).

In surgery of the maxillary sinus, when a window for drainage of the sinus must be made in the inferior turbinate, great care must be exerted to prevent injury to the lacrimal duct, otherwise there may be "tearing" of the eye. Closure of the duct prevents the normal discharge from the lacrimal sac into the inferior turbinate through a small ostium located about half way between the sphenopalatine foramen and the anterior nasal wall.

Extraoral incisions are sometimes torn by retraction when surgery is attempted through an inadequate opening. Incisions should always be made sufficiently long so that in retraction the wound will not accidentally be torn at right angles, for if tearing occurs, it is difficult to suture with a less visible scar resulting than if the proper or extended incision were made.

EXTRACTION INCIDENTS AND ACCIDENTS

Instruments used in extractions—elevators, forceps, etc.—require careful manipulation. The mouth does not offer a large operative field; because of visual and manual difficulties, it is easy for an elevator to slip into the tongue, the floor of the mouth, the cheek or the palate, with resulting injury to such structures as arteries, veins, nerves and connective tissues, and the subjection of the patient to pain, swelling and possible infection.

Undue and improper force exerted on an elevator may loosen or remove an approximating tooth from its socket; the process of elevation of teeth can fracture a jaw, or cause a segmental fracture involving several teeth.

Although nutrient canals may be innocently exposed in surgery or in simple extractions, particularly when the bony buccal plate is fractured, such an instrument accident sometimes can be avoided if a slower and gentler luxation of the tooth is exercised. In such medullary canal exposures the patient, some hours later, may need another anesthesia and bone condensation to stop excessive bleeding which might not appear at the time of extraction because of the vasoconstrictor action in the local anesthetic.

Improperly controlling a forceps in the too-fast removal of a tooth

can cause injury to opposing teeth in the other jaw, such as a crack which, if not immediately seen, develops into one that becomes more noticeable later.

Corners of teeth can be knocked off in extraction, inlays or fillings can be tipped out of place and a tooth pulp can be damaged by an instrument blow, such as when using a short-handled chisel in malleting. It is easy to miss the head of the chisel and hit a tooth, and in certain cases a tooth can be so seriously damaged that the loss of it is inevitable.

Use of the wrong forceps in extraction is dangerous because the beaks could slip off the tooth to be extracted and injure a neighboring tooth.

In alveoplasty operations and some other surgical procedures, even in a simple one-tooth extraction, the pulling and tearing of surrounding mucosa during extraction may expose bone which, because of the mutilated and lost tissue, cannot be covered by the usual socket suturing. Bone denudation can be very painful for days and weeks.

In uncovering unerupted teeth by removal of interfering bone, it is very important not to slip, injure or loosen an approximating tooth or teeth.

Dull rongeurs may cut or break bone more than sharp ones, and bone not intended for surgery may be lost.

Bone rasping should be accomplished with a minimum of strokes for the desired result, as unnecessary bone inflammation, with retarded healing and pain, could easily follow improper use of the rasp.

Uncontrolled slipping of bone burs in bone surgery, such as in reduction of a torus, results in gouging of soft tissue or catching the drill in the tongue. Even the teeth can be injured. Dull bone burs burn bone and inflammation ensues.

RETAINED FOREIGN BODIES

Retention of broken ends of instruments constitutes a danger. In some cases they have been retained harmlessly and carried throughout life, but there is always the possibility that they will impinge on a nerve and cause severe pain or socket infection.

Broken fragments of fillings or of tooth structure may be retained in a socket during extraction, so to be sure there is no foreign body involved, the socket should be aspirated. It is important to use an aspirator tip which will permit access to the apical region of the socket. Certainly one should make a definite effort to see that the socket is free of all foreign material, and for this a good light is imperative. For further precaution, the wise operator, for the patient's

welfare and good will as well as for his own protection and peace of mind, will take roentgenograms following difficult doubtful extractions. He will then know for certain whether there are particles of retained fillings or root tips or if a fracture is present.

Too often operative dentistry or cavity preparation drills, such as cross-cut fissure burs, are used in bone surgery. These are easily broken and should never be used. Bone drills of a larger and stronger type are safer; a bibevel bone drill is less likely to break. Then, too, large drill points can be more easily seen for recovery.

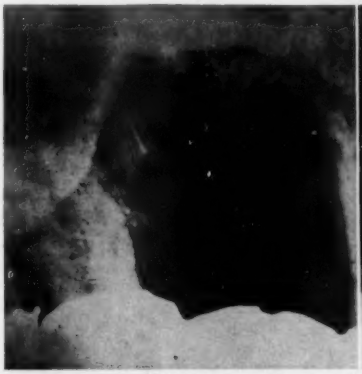

Fig. 2.

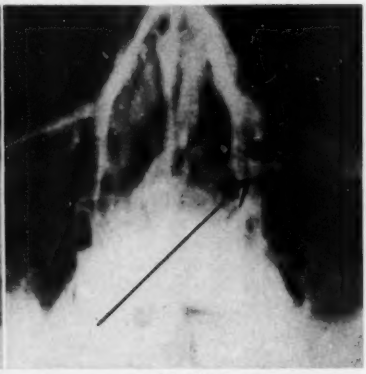

Fig. 3.

Fig. 2. A root tip was accidentally pushed into the antrum, and a root canal filling is seen in the root. The break in the continuity of the floor of the sinus is evident.

Fig. 3. The root tip of a maxillary first molar was accidentally pushed into the antrum, and in an effort to retrieve it, gauze pushed it farther away from the socket and into the space between the middle and inferior meatus. This roentgenogram shows that the root is not in the floor of the sinus, which is where it is most likely to be found.

Whole teeth or root tips are accidentally pushed into the maxillary sinus by the use of unnecessary force in the extraction procedure (Figs. 2, 3 and 4). Likewise, supernumerary teeth or roots are pushed into the nasal cavity, beneath the nasal mucosa (Fig. 5).

There is danger when a mandibular third molar with curved roots breaks leaving one or more roots. Unless great care is exercised the root or roots may be forced through the rather thin lingual plate of bone, just below the mylohyoid ridge, and then into the submaxillary fossa or gland. Recovery of the root requires skillful surgery, patience and a special knowledge of the anatomy of that region. Instrumental removal of such foreign bodies can be accomplished only when they can be seen, and certainly not by blind elevator technique (Figs. 6 and 7).

Fig. 4.

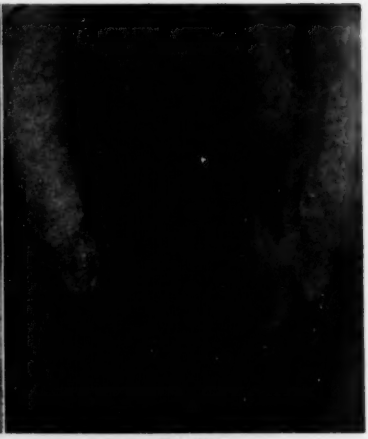

Fig. 5.

Fig. 4. A badly infected antrum followed a successful attempt to remove a tooth root at the time of extraction. This infected sinus required the usual radical antrum operation through the canine fossa and a window into the nose through the inferior turbinate bone.

Fig. 5. By elevator pressure a maxillary central incisor root was pushed into the nasal space.

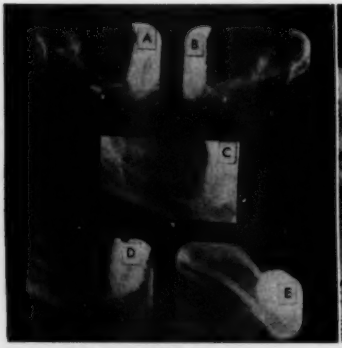

Fig. 6.

Fig. 7.

Fig. 6. In the extraction of the mandibular second and third molars, the second molar root tips broke and were retained in the sockets as seen in *A*. In an effort to remove them one can see in *B* that one root tip was successfully removed, but the other was moved and not removed. (In *B* the film was reversed in preparation.) In *C* it had been moved again to a more distal position, and in *D* it had been pushed through the lingual plate of bone into the submaxillary fossa. In *E* the perforation in the lingual plate can be seen, and there is no evidence of the tooth root.

Fig. 7. This is an occlusal view of the submaxillary region showing no retained root as in Figure 6*E*, but showing the break in the lingual plate of bone.

When searching for a root that has been accidentally pushed into the antrum, great care in the use of instruments and gauze may avoid pushing the root out of reach. With aspiration and by making a larger window the root may be teased toward the opening and recovered in most cases. Otherwise the canine fossa-Caldwell-Luc procedure is preferable if not imperative.

LOCAL ANESTHESIA AND NEEDLES

Although credit is due manufacturers for the great improvement in injection needles, because of their strength and rustless quality, abuse of needles still occurs. To prevent accidental breaking, needles should not be used indefinitely. Often an operator will move his hand from side to side during a mandibular injection, putting a strain on the needle, and if it is bent enough times it will break. Therefore it is better to remove the needle completely and reinject several times than to break it in movement. The hand motion is really a useless one. It does not move the point of the needle any appreciable distance, although the operator's reasoning is that he is trying to get the needle tip nearer the mandibular canal. Not only may this hand motion break the needle but the "feeling" procedure may force the needle against bone, causing a burring of the needle tip, and then on repeated plunges with the burred needle, tissue injury follows with inflammation. This could have been avoided. In medicine and dentistry burred needles have been found to cause what is called a "sterile abscess," and the sore spot, like a canker sore, painfully exists for days. The serious consequences—even legal involvement—of this accidental needle injection need not be enumerated.

It is pertinent here to say that for a very successful tuberosity injection some anesthetists purposely bend a new 1⅝ inch needle, thereby avoiding injection into the pterygoid plexus which may cause an immediate blanching of the face in the infraorbital area, generally followed by a hematoma, swelling, pain and ecchymosis. Hand and syringe motion in the pterygoid region may break a needle, and in this region it can be very difficult to recover.

It is in order too, at this point, to explain the curved-needle technique for anesthesia of the posterior superior alveolar nerve, to avoid the above-mentioned incident. If a 1⅝ inch straight needle is used, it is usually impossible to stretch the lip at the commissure far enough to avoid direct injection into the pterygoid plexus. A straight hub on a curved hub attached to the syringe can be used, or a straight needle can be bent about 45 degrees, which will permit the needle to be placed against periosteum and bone in the infratemporal space of the

maxilla. This injection is quick, positive, simple, and without danger. A heavy gauge needle is safer in this procedure.

When an injection for local anesthesia is unsuccessful, the operator is likely to inject more of his particular solution. Still failing to obtain satisfactory anesthesia, he will make repeated injections. This undoubtedly causes tissue irritation and inflammation, with the usual swelling and pain, and a "hard" area of fibrosis that persists for days and weeks. Such instrumentation injury may be avoided by a better knowledge of the anatomy and nerve supply of the teeth and jaws, for with such knowledge no doubt anesthesia could have been effected with a single injection. An example is failure to recognize that there may be the unusual but nevertheless possible anastomosis of the mandibular nerve with a small nerve from the cervical plexus which may join the mandibular nerve by entering the mandible through a small foramen on the lingual aspect of the mandible about opposite the mental foramen. Anesthetic solution of 1 cc. injected in this area will produce the desired anesthesia.

The nerve fibers and vessels may be injured by injection in the greater palatine canal, causing a temporary anesthesia of the palatal tissues.

Another example of unsuccessful local anesthesia is the injection for anesthesia of the maxillary incisors by infiltrating the anterior superior dental nerve. The disputable question is, are the maxillary incisors supplied by the anterior superior dental nerve or the nasopalatine nerve, or both? In other words, if infiltration anesthesia fails, injection through the palatal pad between the central incisors of the maxillae directly into the nasopalatine canal will produce the desired anesthesia.

In the treatment of tic douloureux by alcohol injections by the infraorbital extraoral approach, a needle may be placed in an incorrect position thereby injuring the eye, blood vessels or other structures. Tissue injury by too much alcohol for any of the various tic injections can cause swelling and pain, and even necrosis, osteomyelitis, and sometimes death.

BONE INJURIES

Chisels used with undue force in reductions of tori can fracture bone and may perforate palatally into the nose. No mallet or chisel should be used for more than twenty-five blows, as a temporomandibular injury may occur.

In open reduction of mandibular fractures, the repeated slipping of bone-holding instruments can cause bone injury resulting in a periostitis, osteitis, osteomyelitis and necrosis.

In surgery for enucleation of a large cyst of the ascending ramus

of the mandible, extending upward to the mandibular notch, injury to the coronoid process or to blood vessels in that region may result. Severe trauma of the coronoid process can result in a fracture, and if the process is in an abnormal position it can interfere with mandibular function by contacting the zygomatic arch. Limited mandibular motion, pain and swelling will result.

It should be stressed here that recognition of the internal maxillary artery is of great importance when there is surgery about the head of the condyle, for the tying-off of this artery near the condyle is most difficult. This artery must be recognized and avoided.

BURNS

Electrosurgical instrument points may burn tissues not involved in the intended surgery.

Antral illuminators should be tested and controlled to prevent skin burns.

Chemical burns have a part in injuries to the oral cavity. Careless application of chemicals, such as trichloracetic acid, or oversaturation of chemicals on pliers can burn the lip, even when the chemical was intended for a remote application on a third molar pericoronal flap. Silver nitrate can burn and discolor tissues. It is undesirable, unsightly and unnecessary. Another example of careless application of chemicals is seen when aniline dyes accidentally touch the lips or face.

MISCELLANEOUS INJURIES

In open reduction of maxillary fractures involving the floor of the orbit, the surgeon knows that the eye may be injured by unprotected dissection, manipulation, or the drilling of holes for wires. Even the wire itself can cause damage, and the proper placement and attachment of the wire to the head frame must be borne in mind to prevent eye damage.

The operative dentist must have steady control of a metal cutting disk. Serious facial and tissue injury can occur, as shown in Figure 8.

An orthodontist must work with great care in applying bands to the teeth; for example, too great tension on apical vessels can easily cause a thrombosis.

The prosthetic specialist must always be mindful of tissue injury in all his procedures.

• • • • •

Some years ago I heard a very informative lecture given by a member of the Harvard Odontological Society at one of its winter meetings.

Fig. 8. A steel cutting disk accidentally slipped out of hand control, cutting the lip, cheek and nose. It fortunately missed reaching the eyes.

He chose as his subject his errors, failures and accidents in the practice of dentistry. This lecture was acclaimed as one of the most unusual and interesting ever presented to the Society and won praise and applause. Every person that evening profited by the recounting of his experiences. Many of us are happy to talk about successes but few wish to disclose the failures. It takes a bold man to tell the truth and a bolder one to record it. Certainly I have benefited from my errors and accidents in my many years of practice in this wonderful profession; after all, there is no substitute for experience. Dentistry, like other professions, grows and progresses only by the practical application of theory.

Until now I have avoided mentioning the unpleasant and disagreeable law suit which often follows instrument accidents in dentistry. When a dentist undertakes to treat and care for his patients he impliedly contracts that he possesses the reasonable ordinary qualifications of his profession, and that he will exercise at least reasonable skill, diligence and care in the treatment of every patient. Malpractice statistics furnished me by an insurance company some years ago, but nevertheless applicable today, revealed that about 50 per cent of over 200 claims against dentists were due to accidents in extractions (90 per cent by the general practitioner and 10 per cent by the specialist in oral surgery). The primary reasons in the cases studied were ex-

traction of the wrong tooth, tooth in the antrum, broken needles, improper fittings of bridges or dentures, etc., but the majority of cases arose from the improper handling of instruments by cutting, slipping of hand instruments with injuries to the lip, tongue, etc., and a small number of claims came from injuries by burns caused by spilling solutions, such as acid, iodine, etc. The least number of cases involved orthodontic procedures.

Let us look at the patient's viewpoint and realize that by our actions we are known. Our best friends are our happy and satisfied patients who make sincere complimentary remarks about us to others, and their recommendation of our treatment may enrich our lives and bring success beyond hope. I believe that the serious and conscientious dentist has one of the hardest lives to live, but it is not without happiness and recompense.

Finally, I offer for your consideration a statement which to me seemed most worthwhile when I read it many years ago. Though I do not remember the source I think it applies to us. "The doers of this world—the strong people—are rarely those who have had placid uneventful lives. Rather they are the ones who have known heartbreak, misfortune and disappointment, and yet have advanced instead of retreated."

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Acute Lesions Involving the Tongue

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AND

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ACUTE TRAUMATIC LESIONS

Lacerations and Mechanical Injuries

Lacerations of the tongue frequently occur during dental treatment, as a result of an instrument slipping or of a bur or disk inadvertently engaging the tongue. Lacerations also may be caused by biting the tongue while talking or chewing, by rubbing the tongue against a sharp carious tooth, or from a blow to the mouth, as in an automobile accident. Following local anesthesia of the mandible, patients will occasionally bite their tongue, and an epileptic may severely lacerate the tongue during a seizure.

Lacerations without Infection. Lacerations of the tongue should be treated immediately using either local or general anesthesia. Small lacerations may sometimes be controlled by merely placing a hemostatic agent, such as Oxycel or Gelfoam, in the wound. Hemorrhage from deeper cuts must first be controlled by tying the smaller vessels with 3-0 plain catgut and the larger blood vessels with 3-0 chromic catgut. If the laceration is sufficiently deep, it may be necessary to place a layer of 3-0 plain catgut in the musculature itself to prevent leaving a "dead space" beneath the surface membrane. If the "dead space" is not prevented, a hematoma will form and may become a

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nidus for infection. After the bleeding is controlled, the mucous membrane is repaired with 3-0 black silk interrupted sutures; these should be removed in 5 to 7 days. Thus, in lacerations of the tongue, whenever possible, healing is sought by first intention.

In rare instances in which uncontrollable hemorrhage occurs, it is necessary to ligate the lingual artery at its origin from the external carotid.

Lacerations with Infection. Because of the presence of oral bacteria, an untreated tongue laceration may become infected and present an acute problem of pain, swelling, inability to swallow, and on rare occasions it may interfere with respiration. It is surprising that many more infected lingual injuries are not seen, but this is most likely attributable to the natural immunity of the oral cavity to its own bacterial flora. The constant washing of the wound by saliva, coupled with its own antibacterial components, probably helps to prevent infection.

A mildly infected laceration of the tongue should be treated with sodium chloride mouth rinses and, if necessary, by débridement. It should then be allowed to heal by secondary intention.

A more severely infected deep laceration requires more intensive surgical and medical intervention. Systemic antibiotic therapy, including penicillin, tetracycline (Achromycin), oxytetracycline (Terramycin), etc., should be started immediately to prevent spreading of the infection by continuity or by lymphatics into the deeper tissues of the tongue and floor of the mouth. It may be necessary under local or general anesthesia to completely débride the wound, control the concurrent hemorrhage, and then suture in an iodoform drain. This drain is removed in 24 to 48 hours. Healing takes place by secondary intention.

Chemical Trauma

Chemical agents are frequently the cause of an acute lesion or "burn" of the tongue. The number of these agents is legion; they include such divergent chemicals as aspirin, phenol, eugenol, lye, hydrogen peroxide, sodium perborate, etc.

Treatment at Time of Occurrence. The treatment at the time of occurrence is immediate flooding of the mouth with plain water; this will both dilute the agent and wash it out of the oral cavity. If the agent is phenol, neutralization with alcohol should be carried out instantly and then followed by copious rinsing with water. A small quantity of sodium bicarbonate or sodium chloride added to the rinsing solution is beneficial.

The traumatized area should then be treated locally with medication to prevent secondary bacterial infection. The coal-tar derivatives, such

as gentian violet, are efficacious. Antibiotics are not necessary at this time and should be used systemically only if secondary infection occurs later. Topical or local antibiotics, such as penicillin lozenges, should not be used.

The patient may require analgesics or narcotics for pain caused by the chemicals. It may be necessary to prescribe a hypnotic for sleep.

Late Treatment of Chemical Injuries. Treatment of the acute problem resulting from an earlier chemical injury to the tongue concerns itself with (1) removal and neutralization of any remnants of the offending agent, (2) prevention or treatment of secondary infection, (3) treatment of pain, and (4) maintenance of the patient's nutrition and fluid level.

These factors may singly or in combination present themselves as an acute situation.

Again, the tongue should be thoroughly cleansed by copious rinsing with water and cleaned with swabs and gauzes. The use of a local bactericidal or bacteriostatic agent is usually indicated; again, the coal-tar dyes, such as gentian violet, are effective. Systemic antibiotic therapy should be started to combat infection already present, and if judgment so dictates, may even be used prophylactically. Pain will generally be present as a major factor and must be dealt with by prescribing narcotics. Because of the pain present in the tongue, the patient may have difficulty in swallowing fluids and food; this may become a secondary acute problem which will require hospitalization.

Radiation Injury

The sequence of symptoms caused by rapid exposure of the body to large amounts of ionizing radiation has been called the acute radiation syndrome.[6] Following exposure there is an initial reaction consisting of prostration and various gastrointestinal difficulties; this is followed by a period of relative well-being. A gradually developing febrile state then occurs with diarrhea, oral ulcerations, infection, hemorrhage and epilation. Death or convalescence with recovery will follow. Therapy is as yet not well understood. The oral ulcerations reported are part of a generalized acute stomatitis; they often occur on the lateral margins of the tongue and have necrotic borders.

ACUTE INFECTIONS

Bacterial Infections

Acute Nonspecific Stomatitis. The tongue is often involved in acute nonspecific infections of the oral cavity. The bacterial microorganisms

found on smears from these lesions are usually *Streptococcus viridans*, *Str. pyogenes* or *Staphylococcus aureus*. This acute inflammatory condition often follows some upper respiratory infection and may also occur following trauma to the oral tissues, since these bacteria are normal inhabitants of the oral cavity. Onset of the condition is sudden and the entire oral mucosa is markedly reddened, with occasional shallow ulcerations often appearing.

Systemic involvement may be present with elevated temperature, malaise and regional lymphadenopathy.

Treatment consists of mild mouthwashes, such as saline or dilute peroxide, and systemic antibiotic therapy, penicillin being the drug of choice.

***Acute Necrotizing Stomatitis* (*Fusospirochetal Ulceration*).** The tongue may be involved in acute fusospirochetal infections of the oral cavity. The common fusospirochetal lesion is acute necrotizing gingivitis characterized by deep ulceration of the marginal gingiva and the gingival papillae. The gouged-out sharply demarcated areas of ulceration are often characterized by the presence of gray pseudomembrane at the margins. The marginal gingivae are markedly reddened. There is a foul odor due to the necrotizing lesion and systemic involvement with elevated temperature may be present. The lesion presents with sudden onset often following or concurrent with some debilitating disease. Necrotizing gingivitis may appear in individuals with no obvious illness or debilitation.

In isolated cases there may be extension of the gingival lesions to other areas such as the buccal mucosa. Acute fusospirochetal lesions of the tongue are rare but do occasionally occur. They are sharply demarcated ulcerations with a grey necrotic margin. These lesions usually occur on the lateral margin but may be found on the dorsal surface. The tongue appears coated. Fusospirochetal ulcerations may occur in cases of pellagra (acute niacin deficiency). Vitamin B deficiency appears to predispose the oral tissues to fusospirochetal infection. These lesions are apparently caused by the fusospirochetal complex of organisms which are commonly present in the oral cavity. Rosebury and co-workers have produced fusospirochetal lesions in the groin of experimental animals by injecting with cultures of the complex of bacteria.

Systemic antibiotic therapy is of value, together with local treatment of the acute necrotizing gingivitis. Acute necrotizing gingivitis is treated by gentle swabbing of the lesions with 3 per cent hydrogen peroxide followed by gentle scaling to remove superficial calculus and food debris. This procedure is carried on for four consecutive days until the gingiva in the involved areas is essentially normal. More

extensive scaling and curettage can be carried out towards the latter part of the four visits as the lesion is healing. Peroxide mouthwashes consisting of ⅓ hydrogen peroxide and ⅔ warm water can be used every three hours. When the acute lesion has subsided, periodontal procedures should be instituted in order to remove any existing chronic periodontal disease and to restore normal gingival contour.

Mycotic Infections

Acute Moniliasis. This is an acute infection caused by *Candida* (*Monilia*) *albicans* and is the most commonly occurring mycotic involvement of the oral cavity. Moniliasis is often seen in infancy but

Fig. 1.

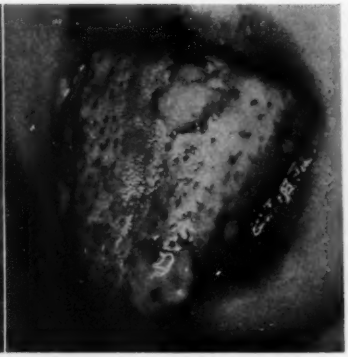

Fig. 2.

Fig. 1. Acute moniliasis in an adult following sustained antibiotic therapy. Note the eroded area (left).

Fig. 2. Lingual involvement in acute herpetic gingivostomatitis. Note the white coating and the numerous vesicles on dorsum and lateral margins.

may also appear in adults debilitated by chronic disease or in individuals on sustained antibiotic therapy where the normally present monilial organisms of the mouth multiply following the decrease in number of the bacterial flora. The oral lesions occur throughout the mucous membrane and are commonly seen on the dorsum of the tongue. The tongue appears to be coated by a thick white film which, upon closer inspection, is seen to be a mass of confluent, raised, small, creamy plaques. The surface can be scraped off with a throat stick or by trauma from mastication, leaving a raw, eroded surface (Fig. 1).

Diagnosis is made by the clinical appearance of the lesion and an examination of the surface film by means of a smear stained with gentian violet or methylene blue. The smear reveals the characteristic spores and mycelia of the monilial organism. Biopsy usually reveals

destruction of the epithelium and invasion of the mycelia into the underlying tissue. The fungus can be cultured on Sabouraud's medium with relative ease.

Therapy consists of application of a 1 per cent solution of gentian violet to the lesions several times daily. Notable improvement occurs in 4 to 5 days.

Rarely, a chronic generalized form of moniliasis occurs and involves the oral mucosa, nails, skin and ultimately the lungs. The pathogenesis of the chronic form is not well understood and therapy has been disappointing.

Viral Infections

Acute Herpetic Gingivostomatitis. This is an acute oral infection caused by the herpes simplex virus and represents the primary reaction of the individual to the viral organism. This clinical entity usually occurs in children from 1 to 3 years of age but may occasionally be found in young adults. As in other oral diseases the clinical picture is often complicated and somewhat exaggerated by secondary bacterial infection. Acute herpetic gingivostomatitis involves the entire oral mucosa. There is a generalized, diffuse redness and enlargement of the gingiva with edema and hemorrhage characteristic of an acute inflammatory condition. The tongue presents a white coating often seen in febrile conditions. Early in the condition numerous small uniform vesicles appear on the gingivae, tongue, buccal mucosa, floor of the mouth and palate (Fig. 2). The vesicles, which may be quite large in some cases, rupture, leaving small ulcerations with a marginal erythema. The ulcerated areas tend to be extremely painful, particularly those occurring on the tongue, and render eating difficult in young children. Vesicles and secondary crusting may be seen on the face close to the oral cavity. Systemic involvement usually is manifested by elevated temperature, malaise and enlargement of regional lymph nodes. The disease runs a specific course of 10 to 14 days, and one attack usually confers immunity to subsequent primary infection. The disease is contagious and will be transmitted to individuals not having immunity; however, most adults have some degree of immunity from prior subclinical infections. The immunity apparently can be destroyed by various factors, and recurrent attacks of herpetic stomatitis have been reported.

Diagnosis is made primarily on the characteristic oral signs. The clinical diagnosis can be confirmed by numerous laboratory tests. Microscopic examination of a herpetic vesicle or ulcer reveals an area of ulceration with acute purulent inflammation. At the base of the

ulcer are numerous swollen epithelial cells with notably expanded nuclei. Special stains reveal viral inclusion bodies within the large nuclei. The large cells with ballooned nuclei may also be seen in smears from the lesion stained with Giemsa's method. Scarification of rabbit cornea and tests for titratable antibodies may also be carried out.

As with most viral diseases, electron microscopy and culture of the virus in various tissue media are fine experimental tools but are not practical for simple diagnostic purposes.

The ulcerations heal without scarring and complications are rare. Antibiotic therapy is of value in combating the secondary bacterial infection, often diminishing the pain and lessening the systemic involvement such as fever and malaise. However, antibiotics do not affect the herpes virus and will not significantly influence the course of the disease. The antibiotic of choice is penicillin. High blood levels can be attained quickly with intramuscular injection or with recent oral preparations such as penicillin V (Pen-Vee, Wyeth); 48 to 72 hours of penicillin therapy is usually adequate. Mild mouthwashes may be of value. Maintenance of adequate nutrition in children may be effected by presenting high caloric foods in soft or liquid form such as ice cream and milkshakes. Tetracaine hydrochloride 1 per cent applied locally before meals affords some relief. In cases of penicillin sensitivity, other antibiotics may be utilized, such as chlortetracycline (Aureomycin), oxytetracycline (Terramycin), or erythromycin. The use of antibiotics locally in the form of lozenge or mouthwash is to be avoided because of possible sensitivity reactions.

Herpangina. This is an acute viral disease, often occurring in epidemics and characterized by the appearance of numerous papules and vesicles on the pillars of the fauces, uvula, tonsils, soft palate and posterior part of the tongue. The vesicles rupture leaving superficial ulceration surrounded by erythema. There are fever, dysphagia and a markedly sore throat. This clinical entity is caused by the Coxsackie group of viruses, has a rapid onset and a specific course of 7 to 10 days.

Therapy is symptomatic. Antibiotics may alleviate some of the acute symptoms by combating secondary bacterial infection. Mild mouthwashes may also help by improving the oral hygiene.

Herpes Zoster. This is an acute vesicular eruption with lesions on skin and mucous membrane corresponding in distribution to an area supplied by a particular sensory nerve. This infection is caused by the herpes zoster virus and usually involves the face, conjunctiva, oral mucosa, larynx and chest. The lesions are almost exclusively unilateral in distribution.

Microscopic examination of a lesion reveals giant cells with balloon-

ing degeneration and intranuclear inclusion bodies, characteristic of viral infections.

The disease runs a specific course and has not responded well to drug therapy, including the newer antibiotics. One attack usually confers immunity.

CHRONIC INFECTIONS WITH ULCERATION AND ACUTE EXACERBATION

Bacterial Infections

Syphilis. Acquired syphilis of the tongue occurs as either the primary lesion of a chancre or as the secondary lesion of mucous patches. Syphilis is the result of infection by *Treponema pallidum*, and both the primary and secondary lesions are contagious. These lesions are rarely acutely painful, but pain may be associated with either stage. The chancre is a raised ulcer with a punched-out necrotic center. The mucous patches are multiple ovoid patches appearing as inflamed raised areas of discrete grayish white lesions; these are usually accompanied by fever and are very rapid in their onset. Pain of either lesion may be related to irritation from foodstuffs while eating.

The diagnosis is established by (1) history, (2) clinical appearance, and (3) serologic tests. The serologic examination is positive in the secondary stage but will be negative for about 3 weeks during the primary stage. Darkfield examination of oral lesions is of questionable value because of the common presence of the Vincent spirochetes in the mouth. The diagnosis and treatment of the basic disease lies with the dermatologist, and the patient should be referred for this.

The treatment of the acute phase of primary or secondary syphilis of the tongue consists of analgesics, use of mild mouthwashes and medications for pain. The lesions themselves respond rapidly to the antibiotics used in the treatment of the generalized disease.

Tuberculosis. Tuberculous lesions of the tongue are the most common oral finding of this disease. These lesions usually appear as an ulceration or a fissure of the body of the tongue (Fig. 3) and are secondary to pre-existing pulmonary involvement. The organism, *Mycobacterium tuberculosis*, is present in the saliva and gains entrance through a break in the integrity of the lingual mucosa. Primary tuberculous infection of the tongue and tongue involvement due to general disseminated tuberculosis have been reported, but these are extremely rare. These lesions may be painless or they may be acutely painful. The microscopic appearance of a tongue lesion of tuberculosis has the usual inflammatory reaction of tubercle formation, with or without Langhans giant cells, and with the epithelioid-type cells and

the surrounding lymphocytic ring present. The diagnosis of the tongue lesion is established by biopsy.

The treatment of acute tuberculous lesions of the tongue consists of (1) local alleviation of pain, and (2) systemic treatment of the pulmonary disease.

The local lesion should be débrided; rarely it may be necessary to excise the ulcer itself. This should be accompanied by the use of streptomycin, 1 gram daily accompanied by PAS (para-aminosalicylic acid) 3 grams four times a day; this treatment should be continued for 2 to 4 weeks. The newer drug, isoniazid, 100 mg. three times a day in

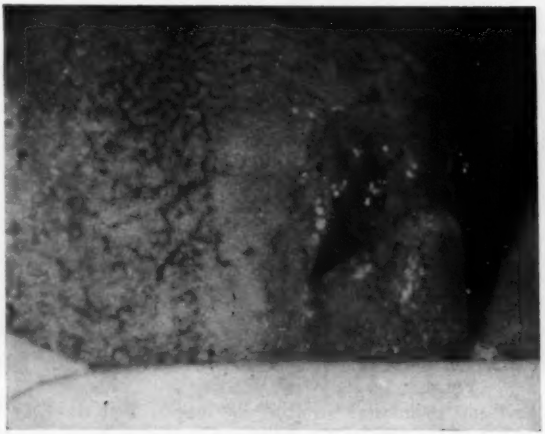

Fig. 3. Tuberculous ulcer of tongue.

conjunction with PAS, 3 grams four times a day is also very effective. The use of 50 mg. of Demerol or codeine, gr. ½ every 3 to 4 hours should be sufficient to control the accompanying pain. Mild mouthwashes and general oral hygiene measures should also be instituted.

Mycotic Infections

Histoplasmosis. Infection of the oral tissues with *Histoplasma capsulatum* is rare, but a number of cases have been reported with lingual involvement. The tongue lesions consist of ulcerations that often begin as a solitary indurated plaque on the dorsal surface. These lesions are chronic in nature, but the ulceration tends to be painful. Biopsy of the ulcerated area reveals a granulomatous reaction with superimposed acute inflammation. The fungus is seen within histiocytes.

The treatment of histoplasmosis has proven disappointing. Antibiotics have little effect.

VESICULAR DERMATOSES

Erythema Multiforme

Erythema multiforme is an acute inflammatory dermatosis with rapid onset and a usual course of one to several weeks with a tendency to recurrence. The lesions are large, deep-red macules, as well as papules, vesicles and bullae (Fig. 4). These lesions are commonly located on extremities, face, neck and often the oral mucosa. Occasion-

Fig. 4.

Fig. 5.

Fig. 4. Erythema multiforme involving the tongue. Note the large ulcerations following rupture of the vesicles and bullae. (Courtesy of Dr. P. L. McCarthy.)
Fig. 5. Pemphigus vulgaris involving the tongue.

ally the clinical picture is complicated by hemorrhage into the lesions.

The exact etiology of erythema multiforme is not well understood, but various factors such as drug sensitivity and certain infectious diseases have been implicated.

Microscopic examination of a lesion reveals a cleavage vesicle with partial separation of the epithelium from the underlying connective tissue.

Erythema multiforme generally responds to cortisone therapy.

Stevens-Johnson Syndrome. This is a serious eruption involving skin and mucous membrane. It is usually seen in children and is considered to be an acute hemorrhagic form of erythema multiforme. Macules and vesicular lesions occur on the genitalia, eyelids, lips and oral mucosa, including the tongue. Ulcerative lesions are common in the mouth. A conjunctivitis, often with secondary crusting, may be present. Typical lesions of erythema multiforme occur on the skin.

Therapy has been disappointing but cortisone has been of value in some cases.

Behcet's Syndrome. This is a syndrome described as a triad of iritis, ulcerations of the oral mucosa and ulcerations of the external genitalia. Skin lesions may also occur. The condition may be a variant of erythema multiforme, but further clarification is required. ACTH and cortisone therapy have proven relatively effective.

Pemphigus Vulgaris

Pemphigus is a serious vesicular and bullous eruption of unknown etiology. Several distinct types of the disease have been recognized, the commonly occurring type being pemphigus vulgaris. The trunk is the usual site of involvement, but the oral mucosa is commonly the site of the initial lesions. Successive crops of vesicles and bullae form in the mouth and usually rupture, leaving extensive areas of deep ulceration (Fig. 5). Microscopic examination of a lesion reveals the characteristic acantholysis with epithelial cells lying loose in the intraepithelial vesicle. A biopsy is often of considerable aid in rendering a diagnosis of pemphigus.

ACTH and cortisone therapy result in remissions, but the therapy must be maintained with continually larger doses, and the long range results have proven disappointing.

Erosive Lichen Planus (Bullous Lichen Planus)

The erosive form of lichen planus may present deep, painful ulcerations on the tongue and oral mucosa generally (Fig. 6). The diagnosis would be made on the clinical appearance of the lesions and the characteristic microscopic findings of parakeratosis or hyperkeratosis, hydropic degeneration of the stratum germinativum and the infiltration of the connective tissue by a broad band of lymphocytes adjacent to the epithelium. In addition to the ulcerative lesions, there may be the typical papular eruption with striations and reticulated patterns.

The etiology of this condition is not well understood, although psychosomatic factors appear to play a role. Therapy is not very successful beyond attempts to relieve the patient of tension.

Acute Disseminated Lupus Erythematosus

Involvement of the lips and oral mucosa often occurs in lupus erythematosus and takes the form of hemorrhagic macules, which may ulcerate. This is one of the collagen diseases, and microscopic ex-

Fig. 6. Erosive (bullous) lichen planus. Note the raw area following rupture of vesicles.

amination of lesions reveals patches of fibrinoid degeneration of the dermal collagen.

This condition sometimes responds to ACTH and cortisone therapy, but many cases terminate fatally. Patients with vesicular dermatoses should be referred to a dermatologist for therapy.

ACUTE ALLERGIC REACTIONS

Stomatitis Medicamentosa

The tongue is often involved in the oral reaction to parenterally administered drugs. The usual clinical picture consists of marked erythema with scattered vesicle formation. As the vesicles rupture the oral mucosa becomes involved, and multiple ulcerated areas develop. Angioneurotic edema may be a feature of the reaction to drugs. Almost every drug can cause sensitization, but certain substances are commonly responsible for the production of oral eruptive lesions. These include barbiturates, phenolphthalein, arsphenamine, arsenical and mercurial preparations, iodides, salicylates, bromides, quinacrine, sulfonamides, penicillin, streptomycin and other antibiotics. Drugs are apparently haptens, or incomplete antigenic substances which unite with tissue proteins to act as allergens.

Treatment consists primarily in withdrawal of the drug responsible for the oral condition. There is no available test for confirming the diagnosis of drug allergy, and antibodies have not been demonstrated in these conditions. Following elimination of the suspected allergen, there is usually a rapid recovery. Antihistaminics are of value for the relief of severe symptoms. In severe generalized drug eruptions, corticosteroids have proven to be of considerable therapeutic value.

Stomatitis Venenata

The tongue may be involved by lesions resulting from actual contact with drugs. Contact allergens are usually simple chemicals which combine with epidermal protein substances to form a complete antigen. The exact mechanism of contact sensitization is not completely understood at present. Substances producing allergic contact stomatitis may be penicillin or other antibiotics in the form of lozenges or pastilles, denture base materials, plastic filling materials, mouthwashes, dentifrices, local anesthetics (particularly topical anesthetics), gum and candy. The oral tissues are markedly reddened, and there is usually an intense burning. Ulcerated areas may form.

Treatment consists in elimination of further contact with the offending agent. Carefully performed patch tests usually reveal the specific drug acting as an allergen. Mild mouthwashes such as saline are of value in supportive therapy. In very severe reactions, corticosteroids have proven of value.

Drugs may produce reactions that are not allergic in nature. These may be due to a toxic effect of the drug or to individual intolerance to a given drug.

It must be remembered that an allergic reaction is produced by a specific drug, and a change in the drug of choice will not produce the allergic reaction. Thus in a reaction to a given topical anesthetic some other agent will probably not act as a similar allergen.

APHTHOUS STOMATITIS

The tongue is frequently involved in cases of aphthous stomatitis (Fig. 7). This condition consists of a recurrent pattern of single or multiple sharply demarcated ulcerations with marginal erythema, occurring in any area of the mouth but more often seen on the buccal mucosa, lower lip, gingiva and lateral borders of the tongue. The etiology of this condition is not known. Previous concepts of a viral etiology have not been substantiated by the work of Blank and others,[3]

where the aphthous lesions presented no evidence of viral inclusion bodies, and neutralizing antibodies were undetectable.

These ulcerated lesions run a course of 7 to 10 days and heal without scarring. Various medicaments have relieved some of the painful symptoms but have not significantly altered the course of the lesions. The use of caustic chemical agents is to be discouraged, since healing is usually delayed even though the pain disappears owing to coagulation of the nerve endings. In selected cases application of fludrocortisone acetate (Florinef, Squibb) has proven beneficial.

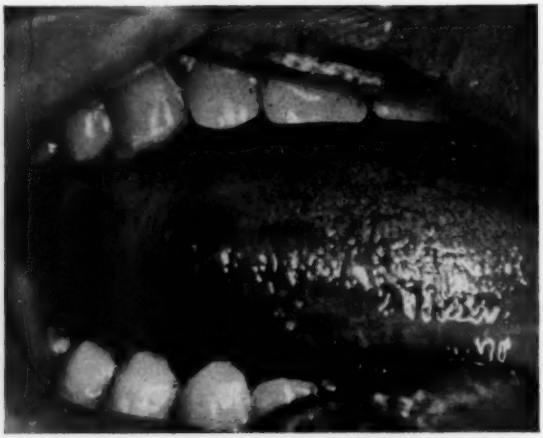

Fig. 7. Small aphthous ulcer on the lateral border of the tongue.

SYSTEMIC CONDITIONS PREDISPOSING TO ORAL INFECTION AND ULCERATION OF THE TONGUE

Diabetes

Diabetes involving the tongue is part of an over-all diabetic stomatitis. Although this is usually a problem of uncontrolled or undiagnosed diabetics with lowered resistance against infection, controlled diabetics often have the same difficulty. Frequently, diabetic patients complain of burning of the tongue accompanied by a generalized dryness of the mouth.

The treatment of acute infection or laceration of the tongue in a patient with diabetes should consist of débridement, hemorrhage control, suturing if necessary, and administration of antibiotics. Because diabetics are unusually prone to infection, untreated tongue lesions in these patients can readily result in large, serious necrotic ulcerations.

The xerostomia, or dryness of the mouth, accompanied by the pyroglossia can be counteracted by increase of fluid intake. Treatment of the acute tongue problem must be carried out in conjunction with the physician who is treating the diabetes. Mild mouthwashes should be used and good oral hygiene should be maintained. A topical antibacterial medication, such as gentian violet, will prove helpful in eliminating the tongue infection.

Agranulocytosis (Malignant Neutropenia)

Agranulocytosis occasionally causes acute symptoms of the tongue, and if accompanied by infection, may lead to very serious difficulties. Agranulocytosis is characterized by a lack of circulating neutrophil polymorphonuclear leukocytes and is usually seen in the older age group. The disease is frequently associated with continued prolonged use of certain drugs, including the aminopyrine group, sulfonamide drugs, gold salts, etc. The tongue becomes ulcerated as part of an over-all acute ulcerative necrotic stomatitis, and spontaneous hemorrhage frequently accompanies the disease. There is a marked fetor oris together with cervical adenopathy and facial swelling.

The treatment of the tongue lesion is concomitant with the treatment of the over-all systemic disease. The offending drug must be eliminated and supportive systemic therapy must be instituted. The tongue lesion should be treated locally by frequent mouth washes of saline or sodium bicarbonate accompanied by treatment of the ulcerative lesions with a topical medication, such as gentian violet. Systemic antibiotic therapy should be instituted immediately, and the over-all care of the patient should be in the hands of an internist.

Leukemia

The various forms of leukemia, including myelogenous leukemia, lymphatic leukemia and monocytic leukemia, may first present themselves as an acute lesion of the tongue. The tongue is generally inflamed and painful and has areas which are denuded. The patient frequently has cervical lymphadenopathy. Ulceration with secondary infection of the tongue accompanied by necrosis and fetor oris is seen, and the tongue may be markedly enlarged and painful. The patient presents the usual generalized symptoms of the various types of leukemia. Burning of the tongue is also a clinical complaint and occasionally there is a spontaneous hemorrhage from the tongue.

The treatment for the acute lesions of leukemia involving the tongue is for symptomatic relief only; this is true for generalized stomatitis in

leukemia. The dentist's efforts should be directed toward keeping the patient's mouth as comfortable and as clean as possible. It is most important that he be aware of the underlying pathology and avoid all unnecessary surgical treatment.

TUMORS OF THE TONGUE WHICH PRESENT AS ACUTE LESIONS

Neoplasms of the tongue, both benign and malignant, may present themselves as acute problems.

Benign Tumors

Angioma. Angiomata of the tongue not infrequently cause an acute hemorrhagic problem (Fig. 8). These lesions are vascular tumors of

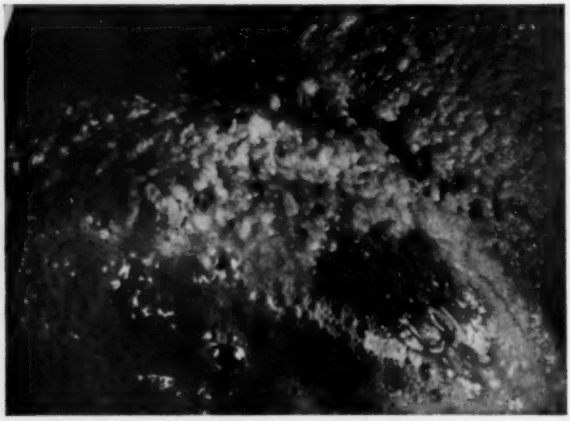

Fig. 8. Two hemangiomata on the dorsum of tongue.

either the blood vessels or the lymphatics of the tongue and may be single or multiple. The patient inadvertently bites into the tumor, causing severe hemorrhage to occur; this can present a very difficult and urgent problem in management.

Suturing of the area may control the hemorrhage but on occasion has been known to increase the hemorrhage by further tearing the blood vessels of the tumor. A good technique for control is to surround the angioma with multiple deep vertical mattress sutures. The use of hemostatic agents, such as Oxycel or Gelfoam, frequently helps. The use of sclerosing solutions is usually effective for long range treatment by causing scarification of the lesion. In several instances it has been

necessary to ligate the lingual artery and even the external carotid artery.

Malignant Tumors

Malignant tumors of the tongue are mainly epidermoid carcinomas. The patient's first complaint is frequently the pain due to acute infection in the area of malignancy. The diagnosis of the tumor should be established immediately by biopsy. The pain is generally due to secondary infection by the oral bacteria. Occasionally the pain may be associated with involvement of a branch of the lingual nerve.

Treatment for the acute phase consists of relieving the pain by medications, such as aspirin or small doses of narcotics, and local treatment of the infection. The treatment of the secondary infection is the same as for other non-specific infections of the oral cavity. The use of a mouthwash of salt water or hydrogen peroxide will help eliminate some of the acute inflammation. Occasionally a malignant tumor erodes a large branch of the main lingual artery; this presents an acute problem in hemorrhage control. The use of hemostatic agents such as Oxycel or Gelfoam plastered against the bleeding area may be sufficient to control the bleeding, but occasionally more drastic measures, including ligation of the lingual artery and even the external carotid artery, must be done.

The treatment of the tumor lies in the realm of the oncologist. Suturing through tumor tissue itself should generally be avoided.

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Acute Infections of Dental Origin

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ALVEOLAR ABSCESSES

The most frequent infections encountered within the oral cavity are the acute alveolar abscesses. These abscesses may be classified as periapical, pericemental and pericoronal. If the general physical condition of the patient is well below par, these infections may be serious and promote a definite hazard to the individual. It is best to hospitalize such cases and keep them under direct control so that better supportive therapy can be given. On the other hand, if the alveolar abscess is the only problem in an otherwise healthy individual, incision and drainage or extraction of the offending tooth can be done on an ambulatory basis.

Periapical Abscesses

The periapical abscess occurs at the apex of the tooth root, so that it is confined within the cortical plates of the maxilla or mandible. In the acute state of this infection, thick pus may readily be evacuated by extracting the tooth; general anesthesia is preferable for the surgical procedure. Penicillin 300,000 to 600,000 units should be administered intramuscularly before or at the time of operation. In an acute, diffuse cellulitis with a temperature elevation of two degrees or more, 600,000 units of Crysticillin with 0.5 gram of streptomycin, twice daily, is advisable. This dosage may be continued for several days depending on the clinical symptoms of the patient. Some patients are unable to take penicillin because of sensitivity to the drug, and they may be adequately protected by other antibiotics such as tetracycline

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(Achromycin), erythromycin (Ilotycin), chlortetracycline (Aureomycin), and others. The recommended dosage of these drugs would be 500 mg. every sixth hour for the first 24 hour period. One gram should be taken daily in four divided doses for the next 3 days. The advised treatment for the acute periapical abscess is early extraction of the tooth, as it is the only feasible method of establishing drainage of the accumulated pus from within the bony alveolus. Once thick pus has formed, adequate drainage is seldom achieved by opening the root canal. Home care of these conditions is important and should be stressed to the patient. Instructions should be given regarding bed rest, forcing fluids, and applying cold compresses or an ice bag externally over the swelling and alternating with a hot alkaline mouthwash every 2 hours. A suitable laxative or a soap suds and water enema is very effectual in toxic conditions, and an analgesic such as aspirin and phenacetin with codeine is recommended for pain.

Pericemental Abscesses

The acute pericemental abscess is not confined in the bone, but arises along the denuded root where the alveolus has been destroyed and extends into the adjacent soft tissue, the buccal or lingual vestibules, or the palatal tissues. Drainage of pus may be satisfactorily established in these areas by incising the fluctuant area of the overlying soft tissue. The tooth need not necessarily be extracted at this time. However, if it is beyond the realm of conservative treatment, extraction can be done. Again, the patient should be adequately protected with antibiotic therapy similar to the therapy mentioned previously.

Pericemental abscesses involving several adjacent teeth in one jaw are sometimes seen, and there is a variation in the treatment of these cases. When the acute pericemental infection does not appear to be limited to one tooth (or perhaps two) but extends throughout the greater portion of the quadrant, it is advisable to only establish drainage. Swelling and pain will be relieved by the release of pus, and a high blood level of antibiotics can then be attained before any extraction is done. Protecting the patient with antibiotics and other supportive therapy prior to extracting the condemned teeth is recommended, as extensive alveolar bone necrosis will be avoided through this procedure.

Pericoronal Abscesses

The pericoronal infection is one that arises about the partly erupted, the unerupted, and, at times, the completely impacted tooth. It is most

frequently seen involving the lower third molar. The pus may be drained by raising or dilating the gingival flap overlying the tooth. An incision of the flap should be made to obtain drainage when an instrument cannot get beneath the flap. Subsequent hot irrigations and antibiotic therapy will control the cellulitis. If extraction is essential, as is so in most cases, it can be accomplished later through a relatively noninfected field. It is necessary to excise some bone to facilitate the removal of many of these unerupted and partly erupted teeth. If this is done through an acutely infected field, healthy bone is opened to virulent bacteria which may lead to osteomyelitis of the operative site. Antibiotics should not be depended on to cover up poor surgical judgment.

SUBPERIOSTEAL ABSCESSES

Subperiosteal abscess is pus confined between the periosteum and the bone. This accumulation of pus is frequently distant from the site of the original infection. A fluctuant, tender swelling is often seen in the vestibule opposite the lower second or first molars when the primary source of infection is from the impacted third molar. The infection migrates subperiosteally along the lines of least resistance and develops a pocket of pus distant from the source. This is more commonly observed following pericoronal and pericemental infections than from the periapical type. In well established osteomyelitis, migratory subperiosteal abscesses are quite a part of the picture. It is through this mechanism that dental infections spread to the associated anatomic structures of the jaws and become of vital concern to the patient and doctor. The acute bacterial invasion breaks through the periosteal bed and strips along the fascial planes, invading the deep anatomy.

ROUTES OF EXTENSION AND APPROACHES FOR DRAINAGE

Acute infections involving the lower molar teeth, particularly the second and third molars, whose roots are below the mylohyoid ridge, may invade the loose alveolar tissue. When this occurs, infection may extend in one or several directions:

1. The submaxillary triangle below the angle of the jaw.
2. The pharyngomaxillary and the submental space just below the mylohyoid muscle in the region of the lower molar teeth.
3. The parapharyngeal spaces,
   a. migrating laterally from the ramus into the posterior pharyngeal space;

b. pointing medial to the ramus; that is, between the ramus and the internal pterygoid muscle and pterygomaxillary space;
c. stripping downward and backward to the tonsillar fossa.

4. Anteriorly along the fascial plane of the muscles of the floor of the mouth, and the infection may confine itself to
   a. above the genioglossus muscle, or to
   b. the space between the genioglossus and the geniohyoid muscle, or deeper in the plane bounded above by the geniohyoid and below by the platysma muscle and posteriorly by the anterior belly of the digastric muscle.

We seldom see the infectious process originate in the submaxillary space and pass on down the fascia of the sternocleidomastoid muscle and point in the sternoclavicular space. The parapharyngeal infection may also pass downward and medially, involving the peritracheal lymph chain and producing a mediastinal abscess. It is not unusual to see infections arising about the teeth and jaws migrate from the pterygoid fossa upward to the infratemporal space. An abscess in this area may strip along the temporal muscle and localize along the temporal ridge of the skull. When pus is confined in the parapharyngeal space, adequate drainage is best maintained through an incision in the submaxillary space below the angle of the jaw, with the line of incision conforming to the facial outlines. This method of approach permits, through blunt dissection, access to both the lateral and the medial sides of the angle and ramus of the mandible as well as the submaxillary and pterygoid spaces.

Abscesses of the neck and floor of the mouth, involving the midline and extending backwards, may be reached through a horizontal or vertical incision in the midline of the neck below the chin. After incising the skin and the superficial and deep fascia and separating the platysma muscle, each of the fascial spaces may be opened by blunt dissection. If necessary, a large Kelly hemostat may easily be passed backward to the angle of the jaw on each side. Adequate drainage may be established by placing perforated rubber tubes through the incision and directing one to each side. This procedure eliminates lateral incisions in the submaxillary area. Pus confined in the pterygomaxillary space produces marked trismus and dysphagia. The mouth may be opened under a general anesthetic. The mucosa, anterior to the pillars of the fauces, is bulging, red and fluctuant. Drainage is accomplished by incising the mucosa carefully and then inserting a hemostat, separating the deeper tissues. Care must be exercised in avoiding the lingual nerve.

Acutely infected maxillary molar teeth may lead to a concentration

of pus within the buccinator space. When an abscess is located medial to the buccinator muscle, it can be drained by incising the buccal mucosa beneath the opening of the parotid duct and bluntly separating the tissues until pus is found. An abscess of long standing in this space will go through the buccinator muscle and confine itself beneath the skin of the cheek. An external incision is made to evacuate the pus. The canine and first bicuspid teeth, when acutely infected, usually produce periorbital edema and swelling along the lateral border of the nose. This is due to the extension of pus through the musculature of the quadratus labii muscle. When the maxillary incisor teeth are acutely abscessed, marked swelling of the upper lip and the floor of the nose is evident, owing to the extension of pus into the orbicularis oris muscle. Pus can be evacuated by intraoral incision and drainage. Through and through drainage is necessary in some cases of temporal and infratemporal space abscesses. External incision through the skin over the temporal area, then stripping along the temporal muscle sheath beneath the zygoma and opening into the vestibule of the mouth, via the infratemporal or deep temporal space, will give adequate through and through drainage of both spaces.

AIMS AND PROCEDURES IN MANAGEMENT

In all of these acute inflammatory conditions involving the oral cavity and their associated anatomic structures, strict attention to the patient's general condition is of the first importance. The toxic symptoms manifest themselves by elevation of temperature and pulse rate, and in some cases the respiratory rate is increased. The patient is dehydrated from fever and inability to swallow sufficient quantities of liquid. Pain is evident, and there is discomfort from swelling of the neck or face.

Our primary concern is to make the patient comfortable and control the infection. In many cases, hospitalization and bed rest are recommended. Pain may be alleviated by prescribing Demerol, 50 to 100 mg. intramuscularly. If a patient requires fluid replacement, 1 to 2 liters of 5 per cent dextrose and water, given intravenously, should be instituted depending upon the amount of dehydration. An antibiotic for the probable type of bacteria usually encountered in these oral infections may be selected from (1) Crysticillin, 300,000 units, twice daily; (2) Dicrysticin, which contains 300,000 units of crysticillin and 0.5 gram of streptomycin, twice daily; (3) tetracycline (Achromycin), 500 mg. initially, then 250 mg. every 6 hours, or 100 mg. intravenously twice daily; or (4) erythromycin (Ilotycin) in the same dosage as Achromycin.

Incision and drainage can then be accomplished with the patient in better physiologic condition than if he had been subjected to surgery in a state of near shock from a period of toxicity. At the time of drainage a culture may be taken of the pus, and laboratory tests will reveal the most effective antibiotic to combat the particular bacterial infection. This eliminates guesswork and shortens the time of convalescence.

The antibiotics presently at our command, either alone or in combinations of two or more, decrease the severity of the signs and symptoms of the acute inflammatory state and, in some instances, completely abort the infection. In most well established fluctuant infections, however, incision and drainage will eventually be required. If proper antimicrobial therapy and general supportive care are administered to the patient early in the disease process, resolution may occur without pus formation. Although many of these cases seemingly improve rapidly with the disappearance of all of the clinical symptoms, a patient may return 10 to 14 days later with a small, painless, isolated swelling. The antibiotic reduced the cellulitis and toxicity, but not the formation of pus. To successfully eradicate all of the infection, a few drops of pus may be liberated by incising the area.

INFECTIONS OF THE MAXILLARY SINUS

Acute infections of the maxillary sinus, secondary to dental infections, may be treated by the oral surgeon. Considering the anatomy of this part that is so closely related to the maxillary molar and bicuspid teeth, one can readily understand the ease with which this air space may become infected. Infections of the molar teeth, whose roots approximate or actually penetrate the floor of the sinus, frequently give rise to acute infections of the maxillary sinus. An antral-oral opening may result during the extraction of upper molar teeth, particularly when the antral floor descends low into the alveolus. If this opening does not heal rapidly, it may produce an acute or a chronic maxillary sinusitis.

When an accidental opening is made into the sinus during the extraction of a tooth, every effort should be made to maintain the normal blood clot in the socket so that normal healing of the socket takes place, thereby closing the antral-oral opening. This may be facilitated by narrowing the opening of the socket by trimming the buccal alveolus, effecting a closer relationship of the buccopalatal mucous membrane. A suture placed through this tissue also affords a scaffolding for the blood clot. The patient should be warned against blowing the nose and vigorous mouth rinsing to avoid destroying the clot. If blood accumulates in the sinus following this procedure, a chronic

sinusitis may result which can be treated with nasal drops or a spray of Privine or Neo-Synephrine hydrochloride ¼ per cent. This helps keep the ostium patent so that the sinus remains aerated, relieves the pain, and helps in the absorption of the old blood. Hot, wet facial soaks and antibiotic therapy also aid materially in eliminating the sinus infections. Both antra are similarly affected in dealing with fractures of the middle third of the face. The fractures extending through both sinuses cause much blood to fill the antra. In some of these cases, it is advisable to open the sinus intraorally through the canine fossa, or intranasally through the inferior meatus, and evacuate the blood. If hemorrhage persists, the sinus may be packed with gauze.

Foreign bodies such as tooth roots, impacted teeth, bullets, and fragments of bone may also cause acute maxillary sinus infections. After preliminary supportive measures of antibiotic therapy and parenteral fluids, if necessary, the sinus may be opened intraorally, by either the Caldwell-Luc or the modified Denker procedure, to remove the cause and afford effective treatment. Occasionally, septa present in the sinus will make the foreign body more difficult to remove; but on entering the sinus through the Caldwell-Luc approach, these septa may be passed over or removed. Acute infections of the maxillary sinuses may follow traumatic injuries. Direct infections may result from compound fractures of the antra or from hematomas of the sinuses resulting from these injuries. However, if the extraneous material which has accumulated within the sinus is not absorbed, acute infection will result and either oral or nasal drainage must be obtained.

Antral lavage helps a great deal in the treatment of acute maxillary sinus infections. A small (No. 18 F.) catheter may be placed through the oral opening into the sinus. The patient's head is placed in an upright position with the mouth almost closed. The end of the catheter is held outside the patient's mouth and, by means of a 20 cc. Luer syringe attached to the outer end of the catheter, the irrigating fluid is forced gently through the catheter into the sinus, washing the contents out through the ostium in the nasal cavity and the nose and into the emesis basin. This helps in keeping the patient comfortable and aids in the eradication of the infection.

The clinical symptoms of acute maxillary sinusitis are classic and are not difficult to recognize. When empyema of the sinus is present, the patient complains of severe pain over that part of the face extending over the zygomatic area, behind the ear, and above and behind the eye. In severe cases the face is swollen, red, and tender, and these symptoms extend to the periorbital tissues. Pain is aggravated when stooping over, and a foul discharge may drain from the nostril on the affected side. All of the teeth in the maxilla of the affected side are

painful and tender to percussion. There is a marked sense of fullness and pressure in the maxilla. The patient is toxic, with elevation of temperature. The history is one of the most important factors in determining the cause, as is true in most infectious processes. Once the diagnosis has been established, the method of treatment may be outlined and carried forth: (1) bed rest, (2) analgesics and sedatives, (3) antibiotic therapy, (4) fluid replacement and electrolyte balance, (5) diet and general supportive care. These infections should not be treated lightly, as serious complications may ensue and all of the paranasal sinuses could become involved, with resulting critical illness.

INFECTED CYSTS

Odontogenic cysts of the jaws may become acutely infected. After the usual supportive care, incision and drainage directly into the cyst will give immediate relief. The cyst may be removed without complications when the acute infection subsides.

OSTEOMYELITIS

Although proper surgical care is given, some of the acute infections of the jaws ultimately lead to osteomyelitis. Very few cases of extensive osteomyelitis of the jaws are seen today. This is probably the direct result of early antibiotic treatment administered by the family physician, who is frequently consulted first regarding a facial or cervical swelling. In cases of osteomyelitis seen today, the patients are not the acutely ill, toxic individuals who were seen fifteen to twenty years ago. Even when osteomyelitis is definitely established, there is little bone destruction and few, if any, extensive sequestrectomies are necessary.

Two cases of osteomyelitis of the mandible were seen recently within a two week period. The one case, undoubtedly, was infected from an unsterile needle or solution used in making a mandibular injection for the extraction of a lower molar. Roentgenograms showed that the entire ramus was involved in the osteolytic process (Fig. 1*A*). Necrosis was evident from the second molar area up to the sigmoid notch of the ramus, with the greatest area of destruction being at the lingula where the hypodermic needle was placed. Acute cellulitis was evident over the affected mandible, and there was an area of fluctuation below the angle of the jaw in the submaxillary space. An external incision was made and drainage was established immediately, and the exudate was cultured. The patient was placed on supportive therapy and erythromycin (Ilotycin) 1 gram a day. The antimicrobial therapy

was carried on for three weeks. No further indication of acute infection was observed and no symptomatic evidence of sequestrum formation, trismus or drainage was noted. Further roentgenographic studies showed regeneration of healthy bone within a six week period (Fig. 1*B*). This continued until new healthy bone replaced the necrotic changes without clinical evidence of swelling, pain, drainage or gross destruction of the jaw.

The second patient developed osteomyelitis secondary to pericemental infection involving all of the teeth of the lower left quadrant.

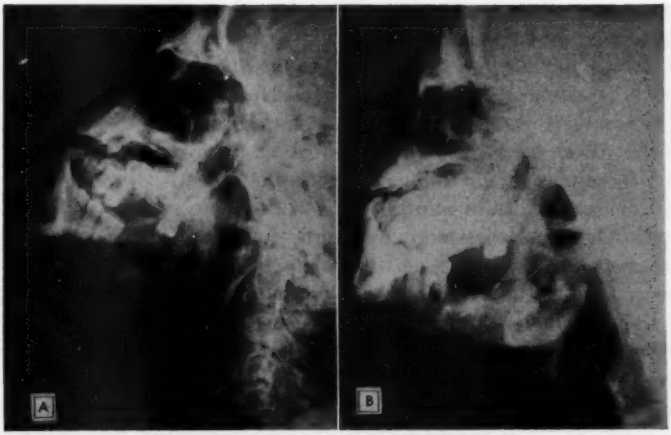

Fig. 1. *A*, Active osteomyelitis of mandible following extraction of lower second molar under local anesthesia. *B*, Almost complete regeneration of bone, disease process completely stopped.

After ten days of erythromycin (Ilotycin) therapy, these teeth were extracted and the necrotic medullary alveolar process was removed by means of gentle curettage. The buccal and lingual plates were sound. There was no exacerbation of the infection and no additional bone was involved. The acute infection subsided quickly and complete regeneration of bone took place. This form of treatment would have been disastrous without the aid of antibiotics. The broad spectrum antimicrobial agents keep the patient with osteomyelitis of the jaws as an ambulatory patient, reasonably comfortable and with very little facial swelling, eliminate external incision and drainage in most cases, and prevent extensive loss of bone from sequestration.

INFLAMMATIONS OF THE SALIVARY GLANDS

Acute inflammations of the salivary glands are seen rather frequently by the oral surgeon. The greater portion of these glandular

inflammations are the direct result of sialoliths blocking the flow of saliva through the duct. Occasionally, the duct is partially or totally closed off by a retention cyst known as a ranula. Normal flow of saliva into the mouth is prevented and the gland retains the saliva, which backs up into the acini of the gland and becomes stagnant. The gland enlarges and pain follows. If this goes on for several days, the inflamed glands resolve into pus. These characteristic stages make the diagnosis quite simple. It is almost axiomatic that when a patient states that a salivary gland enlarges while eating, we first think of some type of blockage of the dependent duct. This may not always be due to a sialolith or a ranula. Strictures of the duct may follow chronic glandular infection, trauma to the duct, or surgical procedures involving the duct or proximal thereto. Neoplasm, by extension, could also involve the duct structures. Acute pericemental abscesses of the lower incisors may extend backward to involve the orifices of the ducts, occluding them to the normal flow of saliva.

Salivary calculi are mostly found in the duct and not in the gland itself. They are seen more frequently in the submaxillary duct and gland than in the parotid or the sublingual glands. It is felt that they are caused by a stasis in the flow of saliva secondary to a tortuosity of the duct or resulting from passage of the duct over the mylohyoid muscle. The bend in the duct here probably causes the saliva to slow down and, perhaps, calcification begins here. Most of the calculi are found in this portion unless they are very small; then, they may pass on to the orifice of the duct. Sialoliths may be felt digitally in the duct structure and most of them may be visualized through proper roentgenographic studies of the gland and duct. The vast majority of these sialoliths are removed intraorally through the duct. Under general anesthesia, the gland may be manually pushed up into the floor of the mouth by the strong fingers of a good assistant. By dissection through the floor of the mouth, the posterior portion of the duct is identified, opened, and the gland may be explored through this superior approach. It is rare indeed that a stone is removed externally from the gland. However, a gland may require excision because a calculus is contained therein. The sialoliths found in the parotid gland and duct are much smaller and are usually removed intraorally through the duct.

The ranula is a very thin-walled retention cyst, involving part of the salivary duct and usually found close to the orifice. These cysts are extremely difficult to dissect cleanly from the duct. The usual technique is to excise the superior border or "top" of the cyst, aspirate the gelatinous fluid within, then invaginate the cut edges and sew to the floor of the duct. This creates a false opening proximal to the normal orifice, and eliminates the problem in most cases. However, these false

openings do not have a sphincter-like muscle as does the normal orifice of a duct; therefore, in these cases we see chronic adenitis from the flow of oral fluids back into the duct and then into the gland.

Infections of the salivary glands are caused by specific pyogenic organisms; other forms of adenitis may occur without specific bacterial invasion. When drainage from the duct can be cultured, administration of the specific antibiotic will clear up the adenitis promptly. If this bacterial sensitivity cannot be ascertained, then a broad spectrum antibiotic should be used on a trial and error basis as a therapeutic measure. A bland diet, application of moist heat externally, and gentle massage of the gland toward the duct are advisable. In some of these infections, even though proper treatment is given, the virulence of the bacteria involves the entire gland, which rapidly breaks down into pus. External incision is necessary to accomplish adequate drainage in these cases. Salivary fistulae occasionally occur; but in time, and without treatment, they heal themselves. Roentgenotherapy is suggested and used by some to dry up the gland in repeated chronic adenitis. Excision of the gland, rather than the use of roentgenotherapy, is recommended as it is a more definite treatment and does not subject other structures to radiation.

STOMATITIS

Among other infections of the oral cavity are the various forms of stomatitis. These may range from the fungus type through the different bacterial infections such as streptococcal, staphylococcal, gonococcal, and fusospirochetal (Vincent's) infection. These are readily controlled with suitable antimicrobial agents. Ulcerative stomatitis may occur as an allergic manifestation following either ingestion or local application of drugs and medications common in a household medicine cabinet, or it may appear as an oral manifestation of systemic disease. The allergens may be disclosed in a detailed and accurate history. By elimination and/or patch testing, those which are the cause may be isolated. The offending substances are then withdrawn from the patient and the mouth is irrigated with an alkaline wash. Any secondary infection that is present is controlled by an appropriate antimicrobial agent.

BLOOD DYSCRASIAS

Blood dyscrasias almost always present oral manifestations. The oral lesions often appear first and the diagnosis is made at that time. Secondary infection may be superimposed on the ulceration caused by the systemic disease. This makes the diagnosis more difficult. Pre-

scribing a suitable antibiotic and an alkaline wash for a few days will clear up the secondary infection so that the lesions may be observed in their true form. The oral lesions will resolve as the systemic condition responds to appropriate medical care.

SUMMARY

One must realize that the oral cavity is not separated from the body but is an integral part of it. Therefore, in all oral infections, the body as a whole, and all of its physiologic functions, must be of concern to the dentist who is caring for these pathologic entities. In treating these acute infections, one cannot limit one's scope to the oral cavity alone. In some of the more extensive and serious cases, it would be advisable to have medical consultation. Acute infections of dental origin are surgical in nature; therefore, it is essential that sound surgical judgment be exercised.

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Retarded Healing of Wounds

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The routine extraction of teeth is such a commonplace occurrence in dental practice that the patient, and often the dentist, scarcely regards it as a surgical procedure. Yet, a wound of some complexity is created, since both soft tissue and bone are involved. The healing of this defect is dependent upon the same tissue responses as are necessary for the healing of more dramatic surgical and traumatic wounds.

This paper will be limited to a discussion of extraction wounds, with emphasis being placed upon causative and preventive factors and corrective measures as they are related to retarded wound healing. More specifically, this discussion will be limited to the entity commonly called "dry socket."

NORMAL HEALING OF EXTRACTION WOUNDS

A histologic review of normal healing of extraction wounds is desirable in order to establish useful clinical data, to provide a foundation for the understanding of abnormal healing, and as a basis for the evaluation of various clinical measures and therapeutic aids.

Animal Studies

Previous to 1923, there were no published systematic, histologic studies of extraction wound healing. Schram[29] and Claflin[8] studied the repair of extraction wounds in a series of dogs sacrificed at intervals to give a time sequence of healing. Both established a time table for the invasion of the blood clot by granulation tissue, organization of

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the granulation tissue into fibrous tissue, proliferation of epithelium across the extraction site, formation of bone and eventual complete repair of the socket and overlying soft tissues. Their histologic and chronologic descriptions corroborated each other. Claflin also was able to study histologic sections of extraction wounds taken from human autopsy material where the extraction dates had been known. He found that the healing of extraction sockets in man was identical to, but slower than, that in dogs. Schram studied the healing of sockets after the careful surgical removal of teeth. He observed that, histologically, such wounds apparently healed more quickly than after forceps extraction. He concluded that the removal of the buccal plate allowed the periosteum to dip in, creating a smaller blood clot which was more quickly organized. The new bone was limited by the position of the flap, which served as a barrier to bone production and did not contribute to it. In the surgical removal of teeth, however, the final rebuilding and contouring of the bone takes longer.

Human Study

Of greater interest to the clinician are the series of studies on extraction wounds in humans done by Mangos[23] and Christopher.[7] The difficulties encountered in removing blocks of tissue from human extraction sites can readily be appreciated. In order to reduce other factors, teeth were chosen for extraction which showed no evidence of periapical or gingival involvement.

A condensation from Mangos' histologic observations will provide a good description of the tissue changes taking place during the uncomplicated healing of the human tooth socket.

3 Day Old Wound. The socket is filled with a blood clot. At the edges of the clot early fibroblastic proliferation and beginning organization is occurring. Bundles of torn periodontal fibers not as yet degenerated are seen. There is no evidence of osteoblastic activity.

7 Day Old Wound. Organization of the clot is progressing rapidly at the crest and fundus areas, the mid portion of the clot is not as advanced. The periodontal fibers appear to be undergoing hyaline degeneration. There is still no evidence of osteoblastic activity.

10 Day Old Wound. The epithelium has proliferated almost across the socket. Organization of the clot is quite advanced at the crest and fundus, but not completely through the mid portion or at the sides of the alveolus. The exposed portion of the clot (surface) shows an acute inflammatory cell infiltration. Osteoblastic activity has started at the crest and fundus, although no bone is present. Osteoclasts are now present at the crest.

2 Week Old Wound. Epithelium has completely proliferated across the surface of the clot. Organization of the clot is complete at the crest and fundus, and quite advanced at the sides. There is no trace of the periodontal membrane, as such, at the edges of the socket. It appears to have merged completely with the newly formed fibrous tissue. There is marked osteoblastic activity at the

fundus and sides, with the formation of bone spicules. Osteoclasts are seen rounding off the crest. An inflammatory cell infiltrate is still marked in the subepithelial layer.

3 Week Old Wound. Epithelium is completely healed across the top of the socket. Fibrous tissue has almost completely replaced the blood clot except for a part of the central area. No evidence of periodontal fibers remains. Inflammatory cell infiltration is still present. New bone formation is pronounced at the fundus and sides, but not at the crestal area. Here osteoclasts are still present.

5½ Week Old Wound. A chronic inflammatory cell infiltrate is now present in the subepithelial tissue. Fibrous tissue is well formed in the upper portion of the socket, less so below. There is more evidence of vascularity in the lower portion of the socket, with bone formation progressing rapidly. Osteoclastic action is still present.

8 Week Old Wound. There is no inflammatory cell infiltrate present. Very dense fibrous tissue is found underneath the epithelium. The socket proper is filled with dense fibrous tissue being replaced by bone formation.

10 Week Old Wound. Bone formation is well advanced. The fundus and lower two-thirds of the socket are filled with cancellous bone of denser but more delicately trabeculated type than the surrounding bone.

15 Week Old Wound. A slight difference in the continuity of the epithelium is the only surface evidence of the former extraction site. The subepithelial fibrous tissue is of normal thickness, and bone fills the socket to the crest.

Both Christopher and Mangos point out that the most active resorption of bone occurs at the tip of the alveolar crests, until a rounded crest results. Otherwise, resorption of bone within the alveolus takes place only in selected areas as part of an internal remodeling process. Therefore, extensive alveolectomy of normal extraction wounds in multiple extractions is not indicated, since complete resorption of the alveolus does not take place, as many still believe. It may again be pointed out that according to Mangos' studies the periodontal membrane undergoes degeneration and does not participate in the repair process (see later). Mangos also made a study of periapical roentgenograms of the sockets taken during the various stages of healing. He found that roentgenograms are of no value in gauging the progress of wound repair.

RETARDED HEALING OF EXTRACTION WOUNDS

Attempts to produce delayed healing are dependent upon the investigator's theories as to its etiology. Claflin succeeded in inducing disturbed healing in the extraction wounds of three dogs. After the extractions, he sealed a tampon saturated with streptococci and staphylococci, obtained from an infected human pulp, into the sockets. One dog was used as a control and remained untreated. Into the sockets of another dog, he placed a paste composed of phenol, glycerin, iodine and collodion; and into the sockets of the third dog were placed the individual components of the paste mixed with collodion.

His histologic studies in the one day old wounds showed that the

blood clot was gone, the crests were necrotic and the periosteum was separated from the buccal plate of bone. In the 10 day old wounds, the epithelium had partially covered the open sockets and small bone sequestra were at the surface. Several sockets showed granulation tissue and others were filled with pus. The bony wall of one socket was necrotic. He found no differences between the treated and untreated sockets, except that epithelial covering was delayed by the packing of the paste.

Christopher, in his study in humans, found several sockets with abnormal healing. His histologic sections from the 8 and 10 day old wounds revealed marked destruction of old bone and the formation of sequestra. Later stages showed a layer of necrotic bone being separated from the socket by osteoclasts. Healing began after granulation tissue proliferated from the living bone surface into the area of sequestrating necrotic bone being broken up by osteoclastic action.

In a recent paper, Alling and Kerr[1] studied the effects of trauma as a causative factor in delaying the repair of extraction wounds in monkeys. After the extraction of teeth, some alveoli were burnished, others were used as a control. Histologic studies showed the typical features of retarded wound healing, with destruction of the periodontal membrane and loss of the blood clot, etc. From this the authors inferred that delay in healing of extraction wounds is correlated with the amount of periodontal membrane residual after extraction. They conclude that the absence of the periodontal membrane prevents organization of the blood clot, which sloughs out, permitting the invasion of organisms and the entrapment of debris. This condition plus the accompanying trauma to the alveolar bone results in an osteitis responsible for the pain and delay of healing.

It is true that burnishing the socket will destroy the periodontal membrane; but burnishing the socket walls will also effectively traumatize the bone, and seal off the small vessels entering the periodontal space from the bone. This burnishing technique finds clinical application in crushing small vessels in the socket and interalveolar septa which sometimes give troublesome bleeding. According to Mangos' study, the periodontal membrane soon degenerates and does not participate in the healing process of undisturbed wounds. The failure of the blood to be organized may better be explained as being secondary to the bone injury and sealing off of the alveolar blood supply.

CLINICAL CONSIDERATIONS IN RETARDED WOUND HEALING

The varying opinions of the causes of retarded healing in extraction wounds have given rise to several terms used synonymously—dry

socket, alveolar osteitis, alveolalgia, and alveolar osteomyelitis. The term alveolar osteitis is preferred, since it more accurately describes the condition.

Clinical Description of Alveolar Osteitis

The patient usually begins to complain of a "peculiar" or fetid taste on the second, third, fourth, or fifth day after the extraction. Soon after, the blood clot is seen to have a dirty grayish cast, sometimes shiny. The clot no longer fills the socket and is unevenly attached to the alveolar wall. The patient is aware of discomfort which quickly progresses in intensity until a severe, throbbing, neuralgic pain is produced which persists for days. Frequently the pain is radiating. The clot becomes semi-liquid after which a foul odor is noticed, but actual pus production is seldom seen. The remnants of the clot may fall out completely, leaving the bony socket denuded of covering; or a semi-solid necrotic mass may persist at the base of the alveolus. The clot may disintegrate after the alveolar orifice is almost closed by gingival proliferation, thus making its detection difficult. A probe or curet placed in the socket will touch bare bone and cause increased pain.[11,12,37]

Causes of Alveolar Osteitis

A review of the literature reveals that many causes have been propounded to explain retarded wound healing.[3,10,11,12,28,37] However, none of them can always be shown to be operative. A wide variety of factors have been theoretically or clinically implicated, a certain number of which repeatedly have been found present in cases of alveolar osteitis. Thoma[37] stated that alveolar osteitis occurs in spite of the most exacting technique, the most careful aseptic procedure, and regardless of the ability and judgment of the surgeon. Because of this, many investigators have recognized that there are predisposing systemic as well as local factors.

Systemic Factors. Acute and chronic diseases, nutritional deficiencies, and the process of aging cause delay or prevention of healing, either directly or indirectly.[12,15,25,28,38] A detailed examination of these disease states is not possible or desirable here. However, brief mention of several will serve to illustrate the complete dependency of wound healing upon systemic health. Diabetes affects every facet of the body economy from resistance to infection to vascular response. Patients with uncontrolled diabetes, even border-line diabetics, have notoriously poor healing ability. The presence of liver disease interferes with cellular metabolism and nutrition, with the storage of vita-

mins, glucose, blood proteins, and with many other processes which are necessary for wound healing. The anemias are directly involved in the clotting mechanism. Vitamin A deficiency prevents epithelial proliferation,[4,17] and vitamin C deficiency will cause capillary fragility and completely inhibit the production of collagen fibers, in whose absence bone cannot form.[4] A sufficient protein intake must be maintained to provide the amino acids necessary for tissue synthesis. Minerals such as calcium and phosphorus are vital for calcification, and vitamin D is necessary for their absorption.[4]

The literature concerning the interrelationship of nutrition and disease and wound healing is voluminous. It should be recognized that subclinical nutritional deficiency and disease states, over a prolonged period of time, will affect the ability of the body to repair wounds.

Local Factors.[26,30] Interference with the blood clot appears to be the first stage in the formation of alveolar osteitis. Continued forceful irrigations or rinsing with fluids may prevent the formation of a clot, or, once it has formed, may wash it away. An ingress of organisms into the socket from the saliva or surrounding gingivae may be infectious; thus the clot becomes a culture medium and is destroyed.

However, an extraction wound and even great bone cavities can readily heal without the presence of a blood clot (as is seen in the healing of wounds which are gently packed).

An excessively traumatic forceps extraction or surgical removal of a tooth, and the excessive local infiltration of an anesthetic containing a hemostatic agent may greatly embarrass the local circulation. This may be accomplished directly by injury to the bone and vascular supply, or it may be due to the release of histamine.[33]

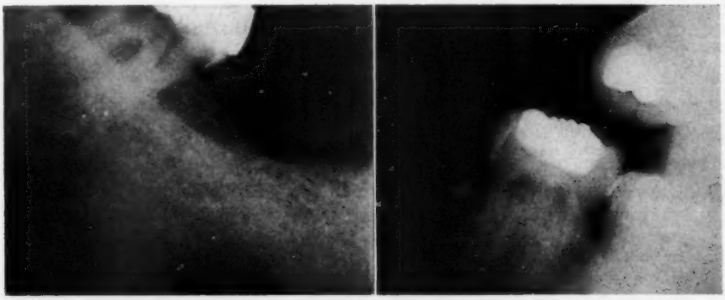
The prediction of dry socket is often made possible by an examination of preoperative roentgenograms, which, in patients having chronic periodontal disease, exostosed roots, and old root canal fillings, will show areas of dense bone in parts or over the entire area of the lamina dura. These areas have been formed as a response to chronic, long continued, inflammatory changes which have initiated localized hyperplasia of bone (also called condensing osteitis). The marrow openings into the periodontal space have thus been partially or almost completely obliterated, with subsequent diminution in the number of blood vessels. Diseases such as Paget's and large endosteal bone formations will also produce the same result (Fig. 1*A*).[28,36]

A Physiopathologic Explanation of Alveolar Osteitis

The following description is offered as a mechanism for the formation of alveolar osteitis. The integrity of the vascular supply to the

socket, and its ability with accompanying tissue cells and fibers to gain access through the cribriform plate of the alveolus into the wound area, are the most basic elements for healing. The maintenance of the blood clot, and the proliferation of granulation tissue (actually bone-forming cells) with or without the presence of a clot, are dependent upon the presence of marrow spaces opening into the alveolus. The vessels and cells capable of producing granulation tissue and bone are contained within those spaces.

Thus, excessive trauma to the bony walls at the time of extraction will crush the marrow openings. Extensive gingival laceration, small bone sequestra, pieces of tooth, and filling materials which have fallen



A B

Fig. 1. *A*, Periapical roentgenogram showing exostosed roots surrounded by dense bone: a preoperative indication of the possibility of dry socket. *B*, Postoperative roentgenogram in a patient having a dry socket following the removal of an impacted mandibular third molar. Note the piece of enamel remaining in the socket.

into the socket will invite infection. The inflammatory response, with its attendant edema, will seal off the small marrow spaces very quickly and produce necrosis of the marrow tissues. The end result of these events is that the blood clot, although formed as an immediate response to the extraction or soft tissue injury, cannot be supported. Its dissolution leads to the clinical "dry socket." Healing must then await recanalization of the marrow spaces. Regrowth of granulation tissue from an area further removed initiates the sequestration process seen during repair.

PREVENTION OF ALVEOLAR OSTEITIS

A study of the histologic findings, coupled with the knowledge of known predisposing systemic and local factors, makes it practical to suggest measures for the prevention of alveolar osteitis.

Preventive Systemic Treatment

The preoperative recognition of gross systemic and nutritional disease is the dentist's responsibility. Little more than casual observation will reveal much. Brittle hair and nails, yellow sclera, prominent thyroid gland and exophthalmus, asthenic physique, bald tongue and pale mucosa are but a few of the physical signs of systemic disease. A simple quick history may elicit important information from the patient (Fig. 2). Often under such prodding the patient may volunteer information which he thought unimportant, since "he was only going to have a tooth removed." For instance, a diabetic may suddenly stop insulin therapy merely "to see how he will get along." If the dentist believes that systemic disease may be present, the patient should be referred to the family physician for further examination.

PATIENT HISTORY

1. Are you in general good health? Do you have a good appetite?
2. What illnesses have you had in the last year?
3. When did you eat or drink last?
4. Are you under a physician's care now?
5. Do you have shortness of breath or asthma?
6. Do you have, or have you had, rheumatic fever?
7. Do you have diabetes or kidney disease? Liver or digestive disease?
8. Do your ankles swell or do you have to sleep on several pillows?
9. Are you allergic to penicillin or to any other medications?
10. Have you had any unusual bleeding incidents?
11. Is there anything about your physical condition the doctor should know?

Fig. 2. A sample history form.

Patients who are to have multiple or full-mouth extractions should be carefully examined. The debilitated and elderly patient may suffer actual nutritional and vitamin deficiencies following such procedures. The postoperative prescribing of vitamin and dietary supplements is good preventive therapy. (Any of the well known vitamin capsules and protein supplements may be used.) Specific dietary instructions should be given to the patient; these should be written. There are many high protein liquid diets available, which may be printed for patient use. Patients who are allowed to guess their dietary needs usually underestimate them grossly.

Preventive Local Treatment

Anesthetic. It has been noted by many clinicians that the extremely apprehensive patient seems prone to develop alveolar osteitis. This may be because of psychovascular responses; or it may be because the dentist infiltrates an excessive amount of anesthetic to insure this patient against pain (less likely).

Surgical Technique. Trauma may be greatly reduced by smooth exodontic movements accomplished with minimal or no luxation. A carefully planned surgical procedure for the removal of a tooth is preferable to prolonged attempts with inadequate exposure. It is a mistake to defer a surgical procedure until the mucosa and alveolar bone have been severely traumatized.

Immediate Postoperative Management of Extraction Wound. *Débridement.* Careful débridement is an important precaution. Sharp edges of alveolar bone should be rasped to prevent perforation of the mucosa. The socket must be inspected for amalgam, tooth and bone particles.[13] Excessive sponging or wiping of the alveolus should not be done.

Management of Blood Clot. The management of the blood clot in a large wound should be carefully handled. The impacted mandibular third molar and other molar sockets appear to have an anatomic predisposition for clot breakdown. The bony walls of these alveoli are more dense than other sockets, indicating, too, a probably decreased blood supply. The size of the blood clot is relatively large, and if there is decreased vascularization the clot is less likely to survive. In addition, the removal of impacted teeth and molar extractions are often unavoidably traumatic procedures. Infection, too, is more likely in these less accessible areas.

The rationale for handling a large blood clot is based on the following:

1. The blood clot may be maintained if it is reduced in size by a drain. A length of ½ inch plain or 5 per cent iodoform gauze is placed in a central area of the alveolus. The gauze should be sufficiently long to reach the apical region, but it should not be packed into the apical end or fundus of the socket. Packing will retard healing by almost completely displacing the clot. Lubrication of the dressing with an anodyne mixture does not appear to increase patient comfort greatly in normally healing extraction wounds. The gauze should remain in place for 3 to 4 days and then be removed after thorough irrigation.

2. Bacterial invasion and clot size may be reduced by insertion of an antibiotic cone or chemotherapeutic agent applied as a slowly dissolving paste or cone or impregnated on a dressing. There is some disagreement among writers concerning the use of antibiotics and chemotherapeutic agents in the preventive treatment of alveolar osteitis. Some investigators claim their use appreciably decreases the incidence of alveolar osteitis,[2,16,21,9] some that they have no more value than unmedicated gauze dressings,[18,19,22,24,34] some write that the sulfonamides retard healing.[20]

Antibiotics and the sulfonamides are recommended in sockets where

there is evidence of infection or gross inflammatory changes. In these instances they are undeniably valuable.[6] The most easily inserted are the oxytetracycline, tetracycline, penicillin and sulfonamide cones. If the dentist desires to use these drugs impregnated on gauze, they should be dissolved in sterile water or saline and the gauze should be immersed in them (see below for amounts). If there is no evidence of infection, or infection is not expected to occur, antibiotics and sulfonamides are not indicated.

3. The blood clot may be supported and reduced in size by a tissue-compatible material. Oxidized cellulose, fibrin foam, and Gelfoam are absorbable when buried within tissues. The cellulose sponge or oxidized gauze may be immersed in a bacteriostatic or bactericidal solution. These also have the advantage of being hemostatics. It has been pointed out that without antibiotic or sulfonamide impregnation, these substances constitute excellent bacterial culture media. Even if they are used in conjunction with antibiotics they may break down unless the overlying mucosa is tightly sutured. A simple technique is to cut a piece smaller than the socket, under aseptic conditions. The oxidized gauze or sponge is immersed in a solution containing 200,000 units of crystalline penicillin or 1 grain of sulfanilamide or sulfathiazole dissolved in 1 cc. of sterile water or saline. The gauze or sponge is then placed well within the socket. Gelfoam has the added property of swelling so that more space is obliterated. It has been claimed that fibrin foam and Gelfoam hasten healing, and that oxidized cellulose retards healing.[14,31,32,35]

It is debatable whether absorbable sponge has any great advantage over a gauze dressing in extraction wounds. If infection is present its use in extraction sockets is open to question, although healing has been reported in infected sockets.

It may be superfluous to add that in single-rooted tooth sockets, or even multi-rooted sockets, covering an undisturbed blood clot with a gauze square for 10 to 20 minutes constitutes the best management, particularly for the small clot.

It has been recommended that in sockets where there is dense bone (such as in condensing osteitis) the alveolar wall be perforated in several places to allow for better healing. Removing some of the dense bone will permit more ready access of blood to the area.[27]

Postoperative Instructions. Definite instructions should be given the patients by the dentist. These should include an admonition against forceful rinsing and self-exploration of the area. Rinsing is discouraged the day of the extraction. Starting with the first postoperative day, the patient is directed to rinse gently every 2 or 3 hours with a glassful of warm water, in which is dissolved ¼ to ½ teaspoon of salt.

TREATMENT OF ALVEOLAR OSTEITIS

Once alveolar osteitis has become established, treatment is directed toward making the patient comfortable and protecting the socket from further injury. Most writers agree that antibiotic or chemotherapeutic substances are not of great value in alveolar osteitis. The following is an acceptable technique for treatment:

1. The socket is gently irrigated with a dilute solution of saline, tincture of Merthiolate or some other antiseptic.

2. The socket is inspected for foreign bodies (including bone spicules), and these are removed. A check-up roentgenogram is taken.

3. The socket is not scarified in an attempt to create a blood clot. This will further spread any infection and cause even greater inflammatory changes.

4. The socket is isolated and dried gently. A paste or sedative dressing is prepared for insertion into the socket. Perhaps the simplest paste is composed of a very soft mixture of zinc oxide and eugenol. This paste is placed into the socket and allowed to flow over the alveolar walls. Another excellent dressing is made by placing equal parts of guaiacol and eugenol on a gauze strip (either iodoform or plain). For large sockets ½ inch gauze should be used, ¼ inch for smaller. Various other obtundant materials such as oil of wintergreen, oil of cassia, and benzocaine have been recommended. It is a matter of the dentist's preference which should be used. The important fact to be remembered is that the gauze should be lightly dressed into all areas of the socket wall for its anesthetic and protective value.

5. The gauze is allowed to remain in place for 1 or 2 days and is then replaced. Several changes of gauze will be necessary, depending upon the severity of the symptoms. Before each dressing, irrigation is performed. When the socket walls are covered by granulation tissue the dressing is shortened until it is finally eliminated. Sequestra of bone that become detached are picked out of the socket.

SUMMARY

A histologic review of normal healing of extraction wounds shows that a socket is completely filled with bone and covered with normal mucosa at the end of 15 weeks. Histologic study of retarded wound healing as it is seen in alveolar osteitis reveals necrosis of the blood clot and large or small areas of the alveolar wall. Healing begins when granulation tissue penetrates the necrotic bone and separates it from the living bone.

The causes of alveolar osteitis are both systemic and local. These causes produce an embarrassment of the local alveolar circulation and prevent organization of the clot. The dry socket produces an extremely painful experience for the patient.

Treatment is best directed toward the prevention of alveolar osteitis. The recognition and correction of systemic predisposing factors and the strict adherence to proper exodontic procedures will do much to eliminate alveolar osteitis.

The treatment of alveolar osteitis is based upon the elimination of pain and the protection of the socket. This is done by the use of sedative dressings.

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Hemangiomas and Related Lesions of the Jaws

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Through the years, the diagnostic acuity of dentists in their clinical and roentgenographic evaluation of lesions of the jaw bones has been gratifying. There are, however, roentgenographic evidences of pathologic lesions that still baffle the most astute diagnosticians.

Of these, none present as formidable a potential as the central angiomas or aneurysms. The types most frequently encountered are the peripheral, arising from the periosteal blood vessels, and the central, arising from vessels within the marrow or cancellous portion of bone. They may be comprised of arterial and venous vessels. Thoma[10] has collected a group of cases which are illustrated to show some of the various types of angiomas found in the jaw bones. They have been classified by the Registry of Bone Sarcoma of the American College of Surgeons as tumors of nonosteogenic origin. He also refers to a group of 28 cases that were tabulated by Bucy and Clapp up to 1930, of which 17 occurred in the skull and 11 in the rest of the skeleton. Of the 17 found in the skull, 5 were located in the jaws. Some of these diffused irregularly, causing excessive destruction and invasion, while others occupied cavities which were well demarcated.

Thoma also describes and illustrates the cases of Crane which could easily be diagnosed as a cyst embracing the teeth of the region.

The rarity of these neoplasms can best be emphasized by a report of Sherman,[8] who was able to report on only a single case of angioma of the jaw that passed through his Department of Diagnostic Roentgenology at Memorial Hospital in New York during his survey. Figi[4] states that the majority of hemangiomas, as high as 95 per cent, are found in the head and neck, two thirds in females. The capillary and the cavernous hemangiomas are the two principal types.

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It is the purpose of the author in this presentation, after evaluating the cases which have been reported and observed and those with which he has come in contact, to suggest some procedures for handling this type of case should one be encountered.

REPORTS OF CASES

In reviewing the literature it appears that of the cases in which were reported serious complications or sequelae, the most serious were found in children between the ages of 10 and 14.

Kroh[6] reports the case of a cavernous angioma in which the patient bled to death a few minutes after extraction. Broderick[1] also reports a case in a girl, age 12, in which there were symptoms of spontaneous gingival bleeding and loosening of the teeth. Root resorption had occurred on teeth extending into the lesion. The patient died after the extraction of the first and second maxillary molars. In this case the external and common carotid arteries on the side where bleeding occurred were first ligated, and finally the external carotid on the opposite side was also ligated. Neither of these procedures aided in the control of this fatal hemorrhage.

Round[1] describes the case of a 12 year old girl whose symptoms were pain and swelling in the region of the superior first molar. The pain was of a pulsating nature and the tissues were red and swollen. The patient was seen first when she was 6 years of age. This condition became worse upon the eruption of the 12 year molar. Spontaneous hemorrhage necessitated the ligation of the external carotid and finally the common carotid arteries without any resultant control of the hemorrhage.

Brodsky[2] describes the case of a boy of 14 which he was able to observe from 1919 to 1933. This case illustrates the invasive and destructive properties of a cavernous angioma and is another instance in which excessive root resorption occurred in the region invaded by the angioma. There was persistent and excessive bleeding following extraction. External carotid ligation was of no avail. At each subsequent surgical episode, hemorrhage was spectacular. Each time, the bleeding was stopped by pressure. Finally, he employed a procedure of drilling holes through the cortical plate of bone which was followed by the use of an electric cautery and finally by the injection of sterile bone wax and Lipiodol. The right external carotid and common carotid arteries were ligated, and finally the left external carotid was ligated. None of these procedures was capable of controlling the hemorrhage.

Erich[3] reports a case upon which he operated. In performing the operative procedure it was possible for him to take sections for biopsy,

wait for frozen sections and finally to curet the angioma from the decorticated cavity with a satisfactory result and recovery. This patient was a 55 year old woman. A case of this type is the exception rather than the rule. Although this was reported to be a central angioma, it was obviously a capillary type in which the blood vessels were so well surrounded and protected by connective tissue that enucleation was possible without overwhelming hemorrhage.

Dr. James Hechtman,[5] of Highland Hospital, Oakland, California, recently told me of a case of a 13 year old white girl who was admitted to the emergency ward with an overwhelming hemorrhage from the gingival tissue in the region of the maxillary first molar. The hemorrhage was so excessive that right and left external carotid ligations were performed at 30 minute intervals, and the bleeding ceased. She was examined by the tumor boards of Highland Hospital and Stanford Hospital, who made a provisional diagnosis of central hemangioma or aneurysm. Definitive surgery was refused by the parent until a year later, when the patient returned with profuse hemorrhage from the original site necessitating an operation for hemi-maxillectomy.

During my association with Colonel Robert B. Shira[9] at Letterman Army Hospital he had occasion to observe and treat a case of angioma of the face and oral cavity (Fig. 1). This case was a combination of capillary and cavernous angioma in a woman in her early thirties. The patient's chief complaint was spontaneous bleeding from the gingival tissue in the region of the right mandibular molars. The condition was always worse at night. The bicuspids and molars were extremely loose. Roentgenograms of the mandible revealed a considerable expansion of the bone in that region with a honeycombed appearance. Because of the mobility of the teeth and the spontaneous bleeding, which was becoming more frequent and excessive, the patient was hospitalized and prepared for ligation of the external carotid artery if necessary. However, the teeth were removed without incident or any excessive bleeding and it was quite apparent that the roots of the teeth did not extend into the large central angioma but were separated from it by a partition of bone.

This patient was observed for 4 years following the removal of the teeth. There were no immediate or delayed postoperative sequelae and the wounds healed uneventfully, with no subsequent spontaneous bleeding thereafter.

SUGGESTIONS FOR MANAGEMENT

In closely scrutinizing the reports and description of the cases which have been recorded, and in retrospect from past experience, it becomes

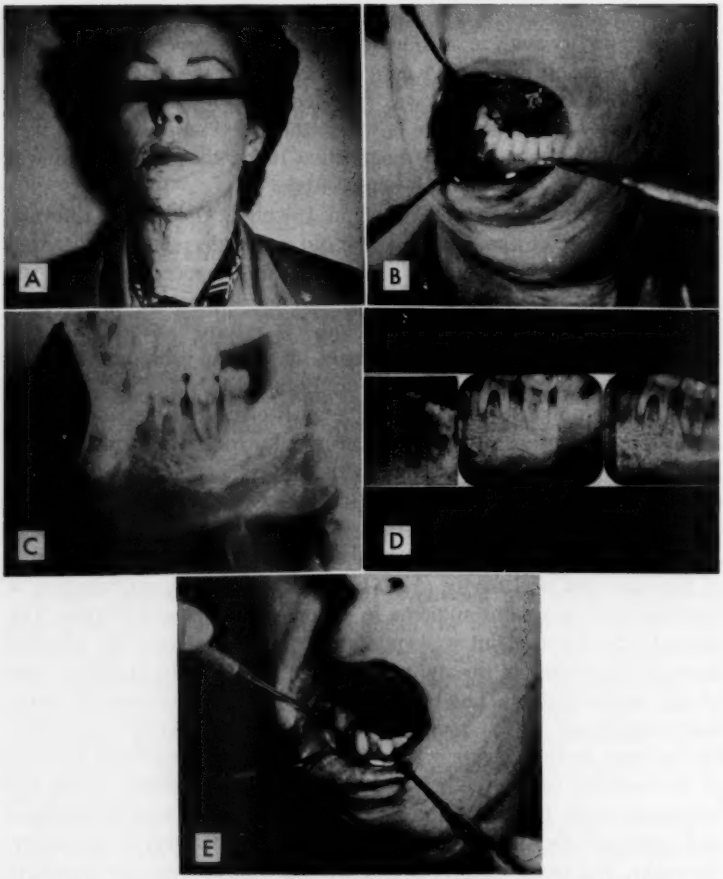

Fig. 1. Hemangioma of the face, mandible, and tongue. This patient presented with a cavernous hemangioma of the face and oral cavity.

A, This photograph shows the full face view of the patient with very excellent plastic procedure which had been carried out to improve the cosmetic appearance.

B, Intraoral photograph showing condition of the teeth. It will be noted that the teeth have become extremely loose, and profuse hemorrhage occurred from the gingival tissue whenever it was traumatized. It was necessary to remove the bicuspids and molars on the right side.

C, Right lateral roentgenogram of the mandible showing the diffuse lesion involving the entire body.

D, Intraoral roentgenograms showing bone destruction about the teeth which accounted for the looseness.

E, Postoperative intraoral photograph. This case was treated in surgery. The face and neck were prepared and all preparations for ligation of the external carotid artery were made. The teeth were extracted and the tumor tissue involving

obvious that certain types of central angiomas can be managed if they are diagnosed. Unless some acute condition or emergency demands definitive treatment without opportunity for preparation or a delaying procedure, many cases can be handled without tragic end results. When any definitive surgical procedure or extraction of teeth is anticipated, a prefabricated, well adapted acrylic splint may be invaluable. Most persons who have encountered angiomas or aneurysms agree that the roentgenogram is an unreliable diagnostic medium. The osteolytic lesion revealed in a roentgenogram may resemble several other types of neoplasms. Tooth mobility alone is inadequate for differential diagnosis. Symptoms of pain, pulsating or otherwise, can also be attributed to many other conditions found around the jaws. Superficial appearance of telangiectasis, either extraoral or intraoral, with or without asymmetry of the bone or soft tissues of the face or jaws, would of course lead one immediately to suspect the existence of a central angioma. Spontaneous interproximal gingival bleeding and a loosening of the teeth in the region appear to have been universally present in practically all of the cases that have been reported.

It must be remembered that although a method for handling such potentially serious conditions may often appear to be radical, the primary consideration is a matter of saving a life. To illustrate the management of two entirely different types of cases I will describe the procedures employed.

Radiation Therapy

The first case is that of a girl who was first seen at the age of 4½ (Fig. 2). History revealed that her mother encountered blood on the child's pillow every night. Her mother took her to the family dentist who in turn sent her to an oral surgeon. Examination revealed a slight facial asymmetry. The right cheek was more prominent and the mucosa of the inside of the cheek revealed superficial areas of telangiectasis. The skin of the cheek was slightly translucent. The two maxillary deciduous molars on the right side were loose, although no odontogenic pathosis was revealed. Spontaneous bleeding from the gingival tissues occurred quite frequently at night and stopped spontaneously.

The case was presented to the tumor board, the ENT service, the

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the alveolar process was removed. The sockets were immediately packed with Oxycel, a strip of tantalum foil was placed over the operated area, and a large compound splint was inserted over the tantalum. The patient's jaws were then immobilized, and by this means, constant pressure was maintained on the operated area. By this procedure the hemorrhage was kept at a minimum and ligation of the external carotid artery was not necessary.

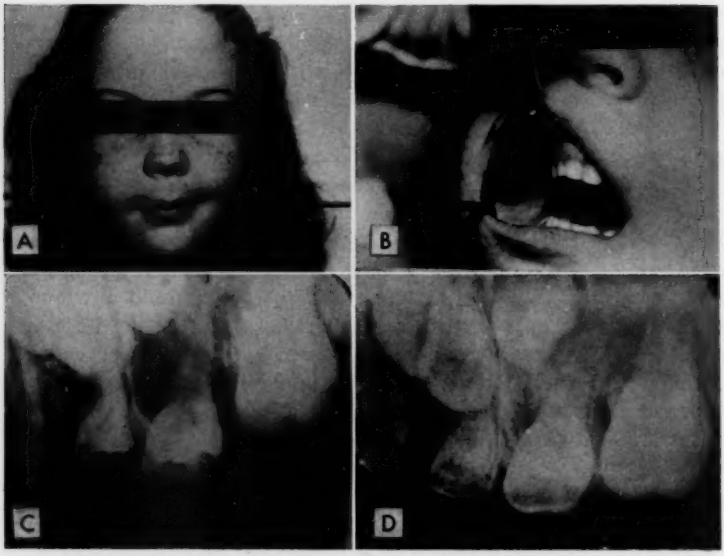

Fig. 2. This patient presented a cavernous hemangioma of the right cheek and maxilla. Its first manifestation was spontaneous hemorrhages about the upper right second deciduous molar. This tooth was extremely loose.

A, This preoperative photo shows the marked asymmetry of the face caused by the tumor.

B, Intraoral view showing the hemangioma of the cheek.

C, Roentgenograms showing the extensive involvement of the maxilla about the two deciduous teeth. This patient received 900 r of x-ray therapy. There was marked recession of the lesion and the deciduous molar became very firm. The patient is to be observed and possibly at a later date additional x-ray therapy will be indicated.

D, Roentgenogram approximately 3 months after x-ray therapy was completed. Note that the bone has regenerated about the root of the teeth.

plastic surgery service and x-ray therapy section and it was decided that surgical intervention would be too mutilating and that radiation therapy should be tried as the treatment of choice. During a period from March 27, 1951, through June 25, 1951—99 days—a total of 900 r (air) were given to a 6 by 6 cm. field over the right malar region. The treatment was given in three individual dosages of 300 r (air) each. Thirty-one days elapsed between the first and second treatments and 68 days between the second and third treatments. The patient tolerated the treatment well and the response was gratifying. At the completion of the treatment the lesion appeared to have been arrested. The two deciduous teeth on the right, which had been loose, were firm and immobile. The patient was seen again in two months following the final treatment, at which time definite regressive changes in the region

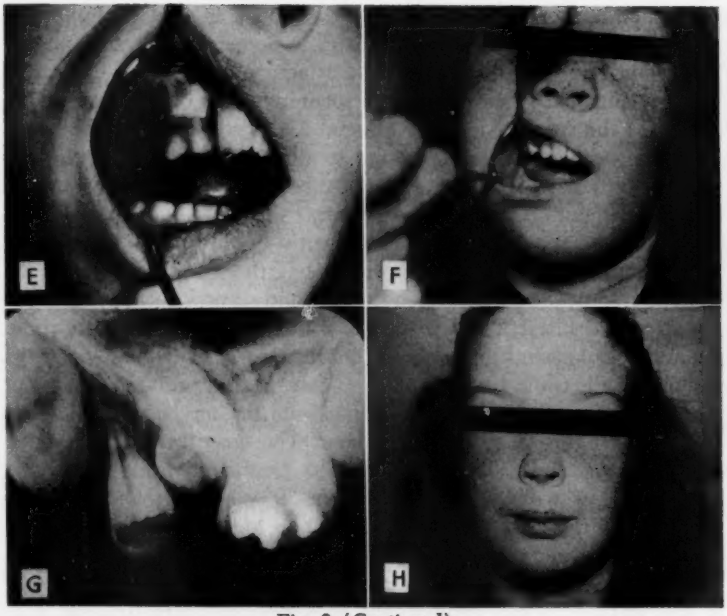

Fig. 2 (*Continued*)

E, Over a period of 2 years the patient received three courses of x-ray therapy totaling 1800 r. There was good clinical response, except for a small area of gingival tissue between the first and second deciduous molars. A small acrylic stent was constructed to hold a low-content radium needle in contact with the tissue. This radiation treatment was used on two occasions of 30 minutes each. There was no appreciable response to this therapy. While the hemorrhage was annoying, it was not serious. Patient was being followed continuously by the Oral Surgery and X-ray departments. It was felt that additional radiation should be given just prior to the time for the deciduous teeth to be exfoliated. This photograph shows the stent in place. It was worn only during the period of treatment.

F, Intraoral photograph showing area of hemangioma of cheek.

G, Roentgenogram showing eruption of permanent teeth in radiated hemangioma area.

H, Full face view at age 11 showing little facial asymmetry.

were noted as well as some regeneration of bone in the osteolytic area involving the right malar and alveolar bone.

At the age of 6, when her first permanent molars erupted, there was a recurrence of her symptoms of spontaneous bleeding and looseness of the first permanent molar. The two deciduous teeth, however, had not loosened. On February 18, 1952, the patient was given a single treatment, 300 r (air) to a 6 by 6 cm. area centered over the right cheek with lead shields to protect the mandible. This treatment was repeated with the same dosage on March 29, 1952. The total dose

calculated at 3 cm. below the surface was 540 r in 41 days. Following this the patient had been observed up to September 30, 1952, and it was again evident that there was a satisfactory regression in the size of the hemangioma. There was infrequent minimal bleeding from the region of the superior alveolar margin. The teeth were in fairly satisfactory condition. No further x-ray treatment was given at this time because it was believed that the tissues had received the maximal dosages without undesirable side effects.

The first permanent molar subsequently tightened and the patient was again asymptomatic. At approximately the age of 8 a small soft-tissue lesion developed between the first and second deciduous molars which would bleed freely whenever traumatized during mastication. An acrylic splint or applicator was constructed in which a low-content radium needle could be installed for a contact application to the lesion. The radium needle was held in contact with the acrylic prosthesis and she received this treatment for 1 hour. The dose was 10 mg. hours, 78 γr at 1 cm. and 255 γr at 0.5 cm. This treatment was repeated one month later at a dosage of 5 mg. hours, 39 γr at 1 cm. and 127 γr at 0.5 cm. The third application was made on May 21, 1953, one month later, at which time the dose was 10 mg. hours, 78 γr at 1 cm. and 255 γr at 0.5 cm. The needle used was 19 mm. long (active length, 12 mm.) and contained 10 mg. radium; the wall thickness was 0.3 mm. P.T. The patient again became asymptomatic and the deciduous molars were extracted at their normal time of exfoliation. The permanent teeth came slowly into their respective position. At the time of the removal of the deciduous teeth there was a small amount of soft tissue hemorrhage. Ordinarily this bleeding would not have been considered. Under the circumstances, a small amount of Sylnasol was injected into the area. This apparently controlled the bleeding. The patient is still under observation up to the present time and the condition has remained asymptomatic. The asymmetry of her face has receded so much that it can hardly be observed.

Resection of Tissue Containing Lesion

The following case will illustrate an entirely different procedure. The author[7] reported a case of a boy 12 years old in which spontaneous nocturnal bleeding over a period of a year finally became so excessive that during the week before the patient was seen by the author it was necessary to administer 3 units of blood. This case apparently differs from most of those that have been described elsewhere in the literature. The roentgenogram revealed a radiolucent area in the mandible which could have been diagnosed as one of several other neoplasms.

None of the teeth in the region were loose and it was almost impossible to see where the spontaneous hemorrhage originated. There was a slight inflammatory proliferation of the interproximal gingival papillae between the first and second mandibular molars. History of spontaneous hemorrhage was the only objective symptom.

In an endeavor to obtain material for biopsy from the lesions beneath the first and second molar teeth it was decided to remove one tooth, and preparation was made to control any excessive hemorrhage in the event it should occur. No sooner had the tooth been loosened than it was literally blown from the alveolus by an overwhelming hemorrhage which was immediately controlled by pressure pads that had been prepared in anticipation of this emergency. The patient was immediately hospitalized and all laboratory work preliminary to transfusion was obtained. The impending overwhelming hemorrhage was so imminent that an external carotid ligation was immediately performed. When the pressure splint was removed to resume the original procedure, the bleeding was just as voluminous as if the carotid had not been ligated.

After 24 hours of deliberation and consultation it was unanimously agreed that the only permanent control of this unprecedented and unpredictable spontaneous hemorrhage could be obtained by a resection of that portion of the jaw containing this lesion. This was done within 24 hours after the patient was first seen for treatment. An uneventful recovery occurred.

Had this case been diagnosed a year before when the spontaneous bleeding was first observed, it might have been possible to arrest the process by some other less radical procedure. The use of the technique employed by Brodsky might have been given consideration. X-ray therapy has been proven to have had beneficial effects on cases in this category. The injection of fibrosing solution may provide an opportunity for later surgical intervention. The employment of surgical intervention itself for exposing the cavity may be expected to stimulate an osteogenetic cycle in a manner similar to the osteogenetic stimulation observed when a traumatic or extravasation cyst is entered for exploration. If this occurred one might anticipate a gradual and final obliteration of the aneurysm. There is sufficient evidence of the efficacy of any of the above-described methods to justify a trial if one encounters such a condition and is capable of an early diagnosis. Electrocoagulation and other similar procedures could also be considered unless when one has gained entrance to the lesion the hemorrhage is so overwhelming that the patient's life is in jeopardy.

Root resorption, although seen in other types of lesions, has been present so frequently in central angiomas that it should not be ignored

as a diagnostic warning. Exploration by aspiration is a procedure that could also be used as a diagnostic aid.

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Immediate Care of Maxillary and Facial Injuries

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The suggestions and cases presented here will describe the precautions and procedures for the practicing dentist who may be called upon to perform emergency services in his office or in a hospital, as the case may be. An attempt will be made to describe these procedures from the viewpoint of basic fundamental knowledge and a minimal amount of equipment.

The immediate care of maxillary and facial injuries involves a fundamental knowledge of facial anatomy. It demands that the general practitioner be familiar with the osseous and dental architecture as well as the vascular and nerve supply of the injured area. He must realize the limitations of his ability in regard to the treatment of these injuries. Therefore, diagnosis plays an important role in the management of both emergency and definitive care. With respect to this important point one can see that improper emergency treatment may complicate the postoperative care of a fractured maxilla. An example of such a situation would be the removal of a tooth containing osseous structure and detached mucoperiosteum in a case of fracture of the maxillary alveolar ridge. In the following discussion an attempt will be made to enumerate the points necessary for accurate diagnosis, treatment and care of maxillary fractures, with special consideration of the precautions to be heeded by the operator.

TYPES OF FRACTURES INVOLVING THE MAXILLA

Three types of fractures are generally accepted as being inclusive of those involving the maxilla:

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1. *Telescoping or pyramidal fractures,* in which the maxilla is pulled back and the upper jaw appears shortened in relation to the mandible. Not only is the maxilla involved but also the nasalis, vomer, malar and cranial bones at times.

2. *Transverse fractures,* in which the face appears dished out, with ecchymosis and swelling in the orbital region; diplopia may be present due to impingement on the orbital socket or the optic nerve. Other facial and cranial bones may be involved.

3. *Horizontal fractures,* usually involving the floor of the antrum and floor of the orbit. The upper lip may be numb and swollen. The fragments are quite often separated at the midsuture line of the palate with variable amounts of displacement of the arches. This may appear quite evident when occlusion is checked. Displacement of the fragments may be downward and backward. Teeth do not occlude. Alveolar fractures of varying degree and severity are included in this category.

A combination of one or more of these three classes may be present.

SYMPTOMS AND SIGNS FOR DIAGNOSIS

1. *Inability to close into normal occlusion* due to displacement of tooth-bearing fragments. Pain may occur on occluding.

2. *Paresthesia* in certain types of fractures involving nerve impingement or damage. Numbness, for example, of cheek, lip and side of nose in infraorbital nerve involvement. Transverse fractures of the maxillae may result in facial nerve paresthesia.

3. *Asymmetry or deformity,* present in certain types of fractures. Dished out appearance in transverse fracture of the maxilla. Displacement of zygoma inward and downward will result in facial asymmetry even in the presence of swelling.

4. *Ecchymosis* due to severance of blood vessel and fluid contained subdermally. Not always in itself diagnostic of a fracture.

5. *Crepitus* on digital palpation due to grinding or gritting of the fractured fragments rubbing on each other.

6. *Bleeding from cavities.* Oral bleeding *may* be diagnostic depending upon location and if coupled with some of the above signs. Nasal bleeding may be due to fractured nasalis or fracture of antral wall.

7. *Mobility* of one or the other or both maxillae as in a horizontal fracture of the maxilla. Alveolar fractures may give mobility of teeth or of a section of the process.

8. *Pain upon mastication* present in the maxilla due to displacement of fragments. Pain on palpation of areas of the middle face.

9. *Roentgenographic.*

a. Waters view for middle face fractures. Stereo-Waters especially good.

b. Verticosubmental for zygomatic arches and position of malar bone relative to maxillae.

c. Lateral mandibular views for further views of the skull and mandible.

d. Periapical views for detail of localized areas. Alveolar fractures specially apparent.

e. Occlusal for anterior view of maxilla and teeth.

f. Posteroanterior for orbits, anterior face and sinuses.

If available, a good radiologist should be consulted to interpret the roentgenograms unless one has sufficient experience in reading of such rays.

Clouding of the sinus may be indicative of blood contained in the sinus due to a fracture of the antral wall.

Suture lines should be checked for separations.

Continuity of bone surfaces should be checked for breaks due to fracturing and displacement, e.g., orbital boundries, sinus walls, etc.

Special care should be used to determine overlapping of fragments; this situation may not be apparent to the inexperienced operator.

Foreign objects may be present and their presence should be ruled out.

Stereo-Waters views are especially useful for picturing the position of the fragments and the amount of displacement.

IMMEDIATE EMERGENCY CARE

Note! If neurologic damage, shock or nausea is present, only extreme emergency treatment should be employed to allay hemorrhage, prevent further infection and diminish pain.

1. Try to determine amount of blood lost and, if necessary, give transfusions of whole blood. If in a hospital, a complete blood count and a differential blood count should be done to give relative blood picture.

2. Shock: give transfusions of plasma or whole blood if severe enough; this should be under the direction of a physician if available. Maintain body temperature by keeping the patient warm and if possible in a warm room. Force fluids.

3. Maintain patient's airway. Mucous secretions, blood, vomitus, etc. may occlude the airway. Suction apparatus should be used to remove all such liquids. Debris, such as broken teeth, alveolar bone and foreign objects should be removed from the oral cavity and pharynx.

Dentures and other prosthetic appliances should be removed. The tongue should be checked to ensure free air passage. If necessary the tongue may be sutured and held from falling back into the mouth. The nostril, if possible, should be cleared of blood clots.

4. Antibiotic therapy should be instituted prophylactically, especially in the case of compound fractures. Tetanus antitoxin should be used if compound wounds are apparent.

5. Pain may be controlled either by aspirin 10 grains or by varying dosages of codeine or Demerol, depending on severity of the individual case.

6. Neurologic damage may be coupled with many of these fractures and if available, a specialist in this field should be consulted if abnormal periods of unconsciousness are present. Spinal fluid flowing from the nose is definitely a danger sign, and additional help should be sought.

7. Bleeding should be stopped either by pressure, by tying off of bleeders or by suturing and hemostasis.

8. Lacerations, abrasions, contusions, etc. should be débrided and sutured if possible and other emergency points checked and taken care of by suggested treatments.

9. Temporary immobilization should be effected by means of a Barton bandage, by temporary wire splints (e.g., figure-of-eight, arch bars, etc.), or by elastics.

10. Obtain primary reduction of grossly displaced fragments, either digitally and by impacting if possible or by arch bar positioning and elastics.

11. Prescribe an adequate diet. Such a diet would be a high caloric, high vitamin liquid diet fortified with such artificial substitutes as Meritene or Sustagen. Vitamin C 500 mg. daily coupled with high potency B complex is strongly suggested.

GENERAL CONSIDERATIONS IN TREATMENT

1. Digital manipulation is especially necessary in telescoping-type fractures, although a reasonable amount of manipulation to disimpact and reimpact is of the utmost importance in even the simplest fractures. Posteriorly displaced fragments can be repositioned by downward and forward traction. Wires may be applied to Ivy loops placed around the teeth and doubled for maximum necessary force.

2. Arch bars may be applied to the teeth by the following method:

a. The arch bar is cut and contoured to what would be the imagined correct shape of the arch after reduction.

b. Single orthodontic brass wire is applied to each tooth and

around the arch bar. One part of the wire (e.g., mesial) goes above the bar and the other (e.g., distal) goes below the arch bar.

c. Individual wires are tightened around the bar.

3. If fragment cannot be impacted and maintained in correct position, a wire may be tied around the applied bar and hooked around the zygomatic arch if the latter is intact.

4. If there is a horizontal fracture of the maxillae and separation at the median suture line of the palate, wires may be tied around the molar teeth of each side and tightened to reposition fragments and immobilize.

5. A simple coat hanger incorporated into a plaster head cast may be used to maintain position of fractured maxillae. Wires are then applied to an arch bar previously positioned to the teeth, and rubber band traction is tied to the contained coat hanger and a wire from the arch drawn through the upper cheek.

6. Where the fracture is slightly fibrosed and immediate reduction is not reasonable because of fibrosis, the upper arch bar may be split in the region of fracture or the midline. Rubber traction is then applied in the opposite direction to the displacement and stabilized to the lower arch bar.

7. Grossly comminuted fractures of the maxilla with an edentulous arch will generally necessitate open reduction.

TRANSVERSE OR HORIZONTAL FRACTURES INVOLVING BOTH OF THE MAXILLAE

This type of fracture is usually due to a violent blow to the upper part of the face and completely detaches the midportion of the face from the upper portion or the skull structure. The fracture line is usually through the nose and suture lines of the orbits. Upon examination it is found that the arch containing the teeth is intact and can be moved up and down as a loose denture. Sometimes it is displaced backward and the teeth (upper) will appear to occlude distally or inside of the lower arch.

This type of fracture can be reduced into position by placing an arch band with lugs about both upper and lower arches. Small rubber bands are then placed from the upper arch lugs to the lower lugs in such a position as to pull the upper arch into proper occlusion. If the correction is considerable it will take from 12 to 24 hours to come into proper occlusion. After the proper occlusion is obtained a plaster cast should be applied about the head and jaw to relieve the downward pull of the lower jaw. The cast must be kept somewhat tight, as it has a tendency to loosen as swelling disappears: snugness can be main-

tained by cutting the part extending downward from the cap or head part to the chin, removing a portion and inserting or drilling holes for rubber bands to connect the lower and upper parts for continual traction. An Ace or elastic bandage will also aid in the upward pull that is necessary to overcome the natural weight of the lower jaw.

This cast can be removed in 15 to 18 days. It is not necessary to keep it on any longer, as these types of fractures have considerable healing surfaces. The rubber bands are then removed from the lower and upper jaws to relieve any strain on the maxillary bone. The arches are retained until it has been determined that no shifting has occurred. If shifting has occurred, the arches can then be used to shift the face in any direction, as solid calcification has not taken place in this length of time.

FRACTURES OF THE ALVEOLAR PROCESS

Cases of a fractured alveolar process containing teeth, such as fractures caused by a baseball bat, usually present themselves at the dentist's office rather than the physician's, because of the displaced teeth and the inability of the patient to close the teeth in proper occlusion.

Intraoral roentgenograms must be taken to determine the height and extent of the fracture. This will determine if the teeth are firm in the fractured fragment or if they are evulsed downward in the socket. After determining these factors, local or general anesthesia can be given. A local anesthetic is preferable because of the time element involved and the lack of general anesthesia in most general practitioner's offices.

After anesthesia has been accomplished and a sedative such as Seconal or Nembutal has been given to quiet the patient, the fragments should be manually put into place and properly occluded with the opposing teeth. To hold the fragments in place, an arch bar of any convenient heavy gauge wire may be used if one of the standard arch bar material is not available. The bar is manually shaped to hold the fragment and teeth in proper alignment. Some small wire such as the stainless steel variety or Angle orthodontic wire is used. This is done by placing a single wire about each tooth, one part of the wire being placed above the arch wire on the mesial aspect and below the arch wire on the distal aspect; the bell of the tooth, or crown, will serve to hold it in place as the wire is twisted. Wires should be twisted clockwise.

In a case involving a displaced single-rooted tooth, a single wire around the neck of the tooth and over the bar is now twisted twice

(not tight or snug around the tooth), the remaining part of the wire is divided and brought down and over the incisal edge and up to the distal and mesial sides of the tooth to the bar, and then twisted together to bring the tooth up into its socket. This stabilizes the tooth in its proper position and allows nature to start healing. After healing has taken place and periodic roentgenograms have determined its condition, root canal therapy can be instituted.

These fractures usually take from 4 to 6 weeks to heal sufficiently before removing their support. This type of procedure is usually used when the anterior teeth and alveolar bone are fractured. The arch is extended from the sound or solid bone and teeth on each side of the maxillary arch. If the fracture involves one or the other side distal to the cuspid, an arch bar is not necessary. These cases can usually be properly stabilized and held in position by putting the displaced fragment into place manually and wiring the teeth together into proper occlusion. The affected side may come into occlusion first, but in forcing the normal occlusion of the opposite side into place the pressure will force the broken fragment up into place. The teeth in the broken fragment must also be wired into proper occlusion with the opposing teeth so as to ensure healing and approximation of the fragments in the proper position.

SIMPLE FRACTURE OF THE ZYGOMATIC ARCH WITH INWARD DISPLACEMENT

Description of Osseous Structures.

1. *Zygomatic Bone.* This bone is small and quadrangular; it forms the prominence of the cheek, part of the lateral wall and floor of the orbit, and parts of the temporal and infratemporal fossae. It presents a malar and a temporal surface; four processes, the frontosphenoidal, orbital, maxillary and temporal; and four borders.

2. *Zygomatic Process of Temporal Bone.* The temporal bone is situated at the side and base of the skull. The temporal bone consists of five parts, the squama, petrous, mastoid, tympanic and styloid process. In this discussion we are concerned only with the squama part of the temporal bone because projecting from the lower border of the squama is a long, arched process, the zygomatic process. The anterior end of the zygomatic process is deeply serrated and articulates with the zygomatic bone.

We are including in this subject the zygomatic bone and the zygomatic process of the temporal bone because of the frequency of fractures existing in both and the singularity of treatment which is usually instituted in the management of fractures of both bones.

These types of fractures are usually caused by a sudden sharp blow by a bottle or a pipe striking the side of the face. The arch is caved in and often impinges on the coronoid process and prevents the patient

from opening his mouth. If the patient can open, the deviation is to the unaffected side to allow the coronoid process to move forward and downward. The physical appearance is that of a depression distal to the cheek bone. Roentgenographic studies from a verticosubmental view would show the extent of the depression and fracture.

If the findings on examination and the history of general health of the patient do not contraindicate a general anesthetic, the patient may be sedated with 1½ grains of Seconal, or a similar sedative, and then put to sleep as for an extraction. Prepare the area with suitable antiseptics and then make a small incision large enough to insert by blunt dissection beneath the zygomatic arch a flat elevator until you feel the underside of the arch. With an outward and upward pull of the wrist the arch can be snapped into place; the forefinger of the other hand is placed over the depression to guide and determine if you have moved the arch into position. One suture is used to close the incision and a small bandage or Band-aid is placed over the wound. Before the patient awakens, place your finger on the lower teeth and your thumb on the upper teeth and see that the mouth will open; in doing so the coronoid will force or help establish its glide path. When the patient has awakened, ask him to open his mouth wide. It will possibly hurt somewhat, but the patient is usually pleased to see that he can open. Instructions should be to continue to open his mouth wide frequently and to avoid sleeping on that side. This we have found to be the least complicated procedure of all in treating a simple depressed zygomatic arch fracture.

FRACTURES OF THE ZYGOMA AND MALAR BONE INVOLVING THE ORBITAL SOCKET

Fractures of the zygoma and malar bone involving the orbital socket and, in many cases, causing diplopia, are handled by the same method. However, the position of the incision and the direction of the force must necessarily be selected to elevate the bones in the proper direction. The left forefinger is placed in the vicinity of the infraorbital notch, as that is the most common place for the inner or near-median line fracture to be displaced; the displacement is usually downward. In reducing the fracture, the fragment can be felt to come up into place and usually will impact itself and stay in position. However, if the displacement is too great and the fragments will not stay in position, a small pin with threads, such as the Roger Anderson pin, can be drilled into the malar bone with a dental hand piece and allowed to freeze into place. The hand piece is then released from the pin. A head

cast with rods suitable to attach to pins is put in place, the fragment is pulled into position and the pins are tightened into place. With proper equipment, this type of fracture can be managed in the dental chair, thus eliminating the necessity of hospitalization.

REPORT OF A CASE OF A COMMINUTED FRACTURE OF THE ZYGOMATIC ARCH

A 32 year old Negro man was admitted to Detroit Receiving Hospital with a compound fracture of the right tibia and pain and swelling about the right upper face. He had a few minor facial lacerations and difficulty in opening and closing his mouth.

The patient had been well until the preceding night, when he had been beaten and robbed. He had had a fractured mandible over three years previously. All other past history and the family history were non-contributory.

Examination revealed a well developed, well nourished Negro man in no acute distress. There was considerable ecchymosis and discoloration about the right upper face and the patient complained of pain when he tried to open his mouth. The right zygomatic arch appeared to be flattened. Blood pressure was 135/85, pulse 85, temperature 99.0° F., respiration 22. Intraoral examination was restricted because of trismus, but the mouth looked clean and there were no lacerations or displacement noted.

A vertex-submental roentgenogram revealed the presence of a comminuted fracture of the right zygomatic arch with the central portion of the arch forced in medially toward the temporal fossa. The Waters view showed the medial displacement of the arch to better advantage. All other roentgenograms proved to be negative for fracture.

The routine blood and urinalysis performed at time of admission were all within normal limits. Serology (Kline) was negative.

The compound fracture of the tibia was set and placed in a plaster cast by the Orthopedic Service and the patient was transferred to Oral Surgery. The patient was given atropine sulfate $\frac{1}{150}$ grain and Seconal sodium 1½ grains preoperatively and brought to Oral Surgery on the morning after admission. In the dental chair, the right upper face was prepared in a sterile manner. After preparation, the patient was given enough Pentothal sodium intravenously (150 mg. initial dose) by the Anesthesia Department to produce light surgical anesthesia. A ¼ inch incision was made through the skin and underlying fascia immediately below the fracture site of the zygomatic arch. A narrow, straight grooved dental elevator was placed in this incision and with blunt dissection was forced through the musculature to the subzygomatic fossa. The elevator was then guided upward and inward until the distal one-third was beneath the arch. With the fingers of the left hand palpating the fracture site, the tip of the elevator was lifted upward and outward away from the lateral aspect of the skull, lifting the fragments of the zygomatic arch. A sharp "popping" sound was heard and the arch held itself in position. The cosmetic appearance was good. The mouth was forcibly opened to clear the muscle pathway beneath the arch. The elevator was removed from the tissue and the incision was closed with a single No. 3-0 black silk suture. A small sterile dressing was placed over the site of the incision. The patient was awake in 3 or 4 minutes and was returned to the ward in good condition.

Antibiotics, cold packs, codeine for pain and a sandbag to keep the patient from rolling over on the arch were ordered for the patient. The suture was removed in 2 days and the patient was discharged from the service. The follow-up roentgenograms showed the arch to be in very good position.

REPORT OF A CASE OF A COMMINUTED FRACTURE OF THE MANDIBLE WITH TREATMENT SIMULATING THAT OF A FRACTURED MAXILLA

This paper has been prepared primarily to discuss the treatment of maxillary injuries; however, the following mandibular fracture is being included. This type of fracture can be discussed in this instance because the nature of its management closely simulates the treatment rendered certain maxillary fractures requiring a head and face cast.

A 22 year old Negro man was seen in the Emergency Room of Detroit Receiving Hospital having sustained multiple facial lacerations and a bilateral compound comminuted fracture of the mandible following an automobile and train collision. Immediate treatment consisted of controlling hemorrhage, débridement and primary closure of the facial lacerations. The patient was admitted to the hospital and transferred to the Oral Surgery Department for immobilization and reduction of the fractured mandible.

Physical examination revealed a well developed, well nourished Negro man in some apparent distress. Blood pressure was 110/80, pulse 84, respiration 18 and temperature 99.6° F. The patient stated that there was "numbness" of his lower lip and that he was unable to open his mouth without some degree of pain. There was swelling of the lower face, particularly in the left submandibular region. Intraoral examination revealed moderate ecchymosis of both lips, cheeks and alveolar mucosa. There was marked salivation and gross malocclusion upon closure. By means of bimanual palpation, marked crepitation, looseness of teeth and distortion of mandibular contour were noted. Essentially the teeth remained intact and attached to the alveolar bone; however, there was a severe coronal fracture of the maxillary right first molar. The remaining maxillary teeth were uninjured and the maxilla was stable. There was evidence of clotted blood about the gingival attachments of the mandibular posterior teeth and apparent swelling of the left mucobuccal fold.

Roentgenographic examination bilaterally showed multiple compound comminutions somewhat conforming to the mandibular contour without gross displacement of any one fragment. The pattern of the fragments was that of loosely arranged pieces of a jigsaw puzzle which had once been fitted together. Oblique lateral projections revealed a medially displaced fracture of the right condylar neck with the condylar head being retained in the glenoid fossa. The teeth appeared to be well imbedded in the fragments without evidence of roots having been fractured. The fracture was considered compounded by virtue of the separations of the periodontal membrane and its association with the oral cavity.

The following orders were written and the patient was scheduled for a closed reduction and immobilization in 2 days: penicillin 600,000 units twice a day; streptomycin 0.5 gram twice a day; Nembutal 1½ grains before bedtime as needed; codeine 1 grain every 4 hours as needed for pain; liquid diet with high caloric and multivitamin content; force fluids; semi-Fowler's position; warm saline mouth rinses three times a day, and ice bags to the left side of the face beginning immediately and continuing alternately off and on for the next 24 hours.

Three days after admission the patient was premedicated with morphine sulfate ⅙ grain and atropine 1/150 grain. Under intravenous Pentothal sodium and nasotracheal nitrous oxide and oxygen anesthesia, the patient was prepared and draped in the usual manner. By means of digital manipulation the mandibular fragments were molded so as to conform to the original contour of the mandibular arch. The accuracy of this reduction was verified by occluding these teeth with those of the maxilla to establish what was considered a normal occlusion. Since reduction of the fracture by this means resulted in the impaction of fragments, a certain amount of immobilization was attained. A Jelenko arch bar was carefully adapted to fit the contour of the re-established arch. This was securely ligated with No. 26

gauge brass ligature wire to the individual teeth. The maxillary right first molar was extracted, and in a similar manner, a Jelenko arch bar was ligated to the remaining maxillary teeth. The right condylar fracture was then reduced by exerting counteracting bimanual digital pressure both intraorally and extraorally. A definite snap of the fragments could be felt when this reduction had been accomplished. The teeth were again occluded and immobilized by applying small rubber bands to opposing arch bars. The fragmented inferior border of the mandible was then impacted by exerting upward pressure with the palmar surfaces of the hand. The patient tolerated the procedure well and left the Operating Room in satisfactory condition.

The patient was examined the following day and stated that he experienced very little discomfort. Moderate facial swelling was noted but the teeth remained in satisfactory occlusion. On the third postoperative day a plaster head cast with a mandibular sling was applied so that some of the interdental elastic tension could be removed and the inferior border of the mandible would be cradled. In addition, the head cast served to protect the mandible during sleep. Antibiotics were discontinued on the sixth postoperative day and the patient discharged from the hospital. Postoperative roentgenograms revealed the condylar fracture to be adequately reduced and mandibular fragments in good position. The patient was followed during routine weekly check-ups and the headcast was removed at the end of the third postoperative week. Elastics were discontinued at the end of the sixth postoperative week and the patient was examined 5 days later. Occlusion was found to be normal and the patient was able to use his mandible adequately without limitations of movement.

In summary, this case serves to illustrate the point that a basic knowledge of fundamental anatomy can be conservatively applied to the treatment of a severely fractured mandible with satisfactory results. It should be emphasized that at no time was open surgery deemed necessary or considered advantageous in the management of this case.

DETERMINATION OF CORRECT OCCLUSION

In injuries of the maxilla or facial bones where the complete upper arch is detached from the skull, it is often impossible to obtain or determine the correct occlusion. In these cases, an upper and lower impression should be taken and then from the models, the occlusion can be determined. In these cases, wires can be passed through the cheeks to an arch bar that has been placed on the upper alveolar arch. With a similar bar on the lower arch, the previously determined occlusion can be established. The wires are attached to a heavy gauge wire imbedded at its end in the head cast and anchored in the front for stabilization. The tension can now be placed on the wires passing over the framework protruding from the head cast. The upper jaw is now stable in relation to the skull and overcomes the downward pull of the lower jaw. Roentgenograms should be taken to determine if the fracture lines are in proper relation. If not, the wires can be tightened or loosened and force can be exerted frontward, sidewise, or backward, as may be necessary to correct the malalignment.

If either the lower arch or the upper arch is fractured vertically and is tipped in or out, the arch bar can be placed about the teeth and then cut at the line of fracture, and rubber traction can be made to pull the fragment into proper relation and occlusion.

In placing arch bars about the teeth, it is of utmost importance to have the bar exactly the shape of the patient's alveolar arch. If it is too narrow the teeth will appear to occlude, but actually they will slant somewhat inward and in doing so the inferior border of the mandible will be displaced. With the teeth in occlusion, the arch bar should fit the general contour. Do not force arches into place by wiring them to the teeth, as this will have an inward or outward pull on the teeth and fragment.

IMMEDIATE CARE OF LACERATIONS OF THE ORAL CAVITY AND FACE

Lacerations often occur in the mouth owing to the slipping of a diamond disk when preparing a tooth for restoration. Many other lacerations are caused in accidents such as in falls or auto collisions. A consideration of their treatment will now be set forth in a stepwise fashion.

Care of Clean Lacerations

Clean lacerations occurring during restorative procedures do not present too much difficulty barring the severance of nerve trunks or blood vessels. If anesthesia is not already present then the first step should be local infiltration to enable the operator to work more efficiently and to make the patient more comfortable during the repair process. Hemostasis will also be facilitated by the epinephrine in the anesthetic solution. Pressure applications should now be placed over the lacerated area to stop the flow of blood. Gauze pads (4 by 4 inches) may be used very satisfactorily for pressure packs. The pads may be saturated with a hemostatic agent or with a local anesthetic solution which contains epinephrine. The packs may be held in place by the operator in cases involving the buccal surfaces of the mucosa; however, in lacerations involving the tongue, the packs can be secured by placing them in sufficient bulk between the arches. Once hemostasis is accomplished, a thorough and intelligent inspection of the wound can be made.

Closure of Wound. If the laceration is deep and involves muscle layers but does not sever blood vessels, then deep buried sutures can be used to close the underlying layers. Chromic catgut sutures, absorbable in nature, are the materials of choice since no unfavorable reaction occurs in the healing process. The ends of the sutures should be

cut as short as possible to avoid irritation from the sharp edges. The sutures are tied in the usual fashion as in approximating mucous membrane. All the deep layers of the muscle should be approximated, but not tied so tightly as to produce dimpling or bulging. During this phase of the suturing process, the area should be kept constantly dry of blood and saliva by means of a small gauze pad. This will enable the operator to have a clear field of vision and also to flatten ends of lacerated muscle. An aspirating device is not indicated here since the suction will pull layers of tissue from correct position. Hand ties may be used here in preference to use of the needle holder because they enable the operator to better control the suture material and position of layers.

When all the deep sutures have been tied the superficial layers may now be closed. Silk or Dermalon materials may be used for this final phase. The needle should be inserted and withdrawn at equal distances and at equal depth from the laceration. Passing through one side of the laceration at one depth and deeper on the other side will cause the closure to have a dimpled, overlapping appearance which will heal with a ridge. The exact number of sutures to be placed differs for each individual case. Approximating sutures may be added after a sufficient number of tension sutures have been applied to bring the edges of the tissue together.

After the suturing has been completed most of the bleeding will have stopped unless "bleeders" were present and have not been tied. Generally no further injectable medications are necessary.

Management of Severed Blood Vessels. Severed blood vessels may be found and tied in the following manner: The laceration is held open and gauze sponges are applied to dry the field of fluids. Careful examination will show the origin of flow. The "bleeder" is then clamped with a hemostat and the field is again checked for further bleeding. Chromic suturing material is used to tie off the vessel in this fashion: The hemostat is held in one hand and the suturing material is passed around the tissue, which is grasped in the hemostat point, and a single hand tie is made. The hemostat is now removed and the field is again dried. If no blood is seen oozing or spurting from the vessel, the second step of the tie is made. The ends of the suture are again cut as short as possible.

Care of Contaminated Lacerations

Débridement. Many lacerations due to physical trauma are not clean, smooth cuts, and the resulting edges require trimming of fine threads of tissue. This tissue will hinder a good closure and should be

trimmed with surgical scissors. These threads of tissue will become necrotic and should not be maintained; therefore, careful trimming of these edges is a necessity. Areas of infection contained within the laceration or about it may be shaved with a scalpel until fresh tissue beneath is exposed. Free bleeding from these shaved edges should not be feared, but rather considered sufficient evidence of the presence of healthy tissue and absence of necrotic and infected material. All foreign objects such as glass, teeth and metals should be removed from the laceration to promote normal healing.

The débrided area should be flushed with sterile saline, but if this is not available, local anesthetic solution can be used to remove all particles of debris.

Closure of Wound. If the laceration is on the face the same procedure described for clean lacerations may be followed, but it is suggested that a fine suturing material be used with an atraumatic needle. No. 5-0 Dermalon suture is the material of choice. Furacin-saturated gauze may be applied over the closed laceration to keep the edge moist and promote healing.

Through-and-through Lacerations. Through-and-through lacerations present more difficulty for a number of reasons: (1) Debris is often present in the wound and care should be exercised to ensure removal. (2) Contamination from the mouth often results, causing tissue sloughs and infection. (3) Drainage may have to be included owing to infectious processes.

Postoperative care should include the following:

1. Warm saline mouth rinses at least every hour. This will promote healing, will prevent surface infection and discourage the accumulation of debris in lacerated areas.
2. Antibiotic therapy should be instituted in cases of:
   a. Intraoral-extraoral lacerations.
   b. Lacerations remaining untreated for any period of time and containing infection or necrotic material.
   c. Lacerations contaminated by debris.
   d. Patients whose systemic health warrants the use of antibiotics (e.g., diabetics, those who have anemia, etc.). Such therapy should be accomplished by administration of either penicillin, 600,000 units daily, or tetracycline, 250 mg. every 6 hours.
3. Approximating sutures should be removed in 3 to 5 days, the remaining sutures in 10 days.

* * * * *

In considering the immediate care of maxillary and facial injuries, it will be well to keep in mind that "immediate care" does not necessarily

mean that an injured person must be taken care of and the case completed at once. The families of those injured do not realize that many things have to be done in advance of an operation before the actual procedure can be undertaken. The patient's general health, the possibility of a skull fracture, concussion, internal injuries and then the laboratory work, all must be taken into consideration before one can safely immobilize the patient's jaws.

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Accidental Exposure of the Maxillary Sinus During Dental Operations

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ANATOMIC AND PHYSIOLOGIC CONSIDERATIONS

Exposure of the maxillary sinus may occur during removal of the maxillary molars and premolars. The roots of these teeth frequently contact the alveolar floor of the sinus. As the maxillary antrum expands with age[2] the incidence of traumatic exposure tends to increase with a comparable advance in life. Destruction of the alveolus from dental infections tends to increase the incidence of accidental exposure during tooth extractions.

Facial types seem to influence the outline and extent of the maxillary antrum and its relationship with the roots of the maxillary molars and premolars. The squared type of face exhibits heavier and wider alveolar structures with a flat palatal vault and a low maxillary zygomatic junction. This presents a heavy mass of bone in the alveolus that is resistant to pressure applied during molar and premolar extraction. The roots of these teeth are solidly embedded in this heavy mass of bone of the alveolus, thus leading to possible root fracture during forced extraction. Fragments of these fractured roots may lie near the antrum but are separated from it by dense alveolar bone. Exposure of the maxillary sinus in this case results from the overapplication of force owing to the employment of improper elevators.

The tapering, long face may indicate a high palatal vault with a high maxillary zygomatic junction. This tends to reduce the bulk of

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the alveolar ridge support and increase the vertical dimension of the maxillary sinus.

The buccal roots of the maxillary molars occupy a vertical position with some distal inclination within the alveolus. The palatal roots, on the other hand, are longer and assume a definite palatal inclination. The buccal roots are the more frequently involved roots in alveolar extension of the maxillary sinus. This tends to progress with age as the maxillary sinus expands with advance in growth.[2]

Because of its inclination toward the midline, the tip of the palatal root may not extend into the alveolar floor of the antrum but may lie in close relationship to it. Undue forces applied during extraction of molar teeth would create damaging pressure to the thin layer of alveolar bone surrounding these roots. Dentists should realize that this layer of alveolar bone is extremely delicate and yields readily to undue force with consequent perforation of the thin, delicate mucosa of the antral floor. The alveolus frequently fractures more readily than the roots of the maxillary molar teeth,[1] especially in individuals with sclerosed bone and infection.

PREVENTIVE MEASURES

Accidental exposure of the maxillary antrum is avoided by careful preoperative examination and preparations. The presence of an alveolar extension of the sinus and the density of the alveolar bone is demonstrable with roentgenograms. A planned operative procedure entailing relief of the buccal alveolar plate or sectioning of the tooth roots at the trifurcation reduces the undue application of pressure on the antral alveolar floor and permits removal of the roots with less damage to the surrounding structures. The dentist who has had no experience with this type of anatomic aberration of the antral floor may prefer to refer the case to someone more experienced in performing this type of extraction.

MANAGEMENT OF AN ACCIDENTAL EXPOSURE

Should an accidental exposure of the maxillary sinus occur during molar and premolar extraction, the continuity of exposed antral mucosa should be respected at all times by avoiding its perforation. Any break in the continuity of the antral mucosa will introduce mouth infections and their consequent complications. Preservation of an intact antral mucosa will always facilitate future closure of the mouth wound following extractions of maxillary molars. Should accidental exposure of the antrum occur during dental operations, the operator should not aggravate the trauma by further instrumentation. It is his

duty at this time to pass the case to someone more familiar with the intricacies of the antrum of Highmore and its relationship with the mouth tissues.

Any plan of treatment for accidental exposure of the maxillary sinus during dental procedures should include (1) study of the involved structures by adequate examination, (2) selection of the proper armamentarium, and (3) immediate closure of the defect.

Examination of the Involved Structures

Careful examination of the area may reveal an intact antral mucosa which appears bluish gray. Probing about this mucosa should be avoided at all times, since it is a very delicate and readily traumatizable membrane. Re-examination of the preoperative roentgenogram should verify the presence of a low antral extension in the surgical area. Probing and curettage of the antral mucosa, which may be mistaken by the inexperienced for a cyst, will complicate the picture and introduce the insult of mouth infection into a perfectly sound antrum. The antral lining is easily torn. A relatively simple procedure of treatment may become an extremely difficult and obstinate undertaking.

All extracted teeth should be examined for any adherent fragments of bone and fractured roots. Detached pieces of buccal alveolar plate do not complicate closure, since it may be necessary to reduce the bulk of width of alveolus to facilitate coaptation of the oral mucosa. The presence of bulky alveolar bone at the site of trifurcation of molar roots creates a more serious problem of healing. A defect usually arises in the center of the ridge and may extend toward the palate. Closure of these wounds is more difficult to accomplish.

Selection of an Armamentarium

Sufficient instruments for treatment of accidental exposure of the maxillary antrum are selected, sterilized, and kept in readiness so that they may be available for immediate use. Treatment of exposure of the sinus should proceed with a minimal loss of time; this reduces the contamination of the maxillary sinus from the mouth bacteria. Anesthesia should be continued or augmented when necessary. Prolongation of the operative procedure is less upsetting to the patient than a delay in necessary treatment.

Instruments necessary for treatment of exposure of the maxillary sinus must include a good suction apparatus. This apparatus should be an aspirator type with a small suction tip. Saliva ejectors commonly used in restorative dentistry are most inadequate. Good lighting is essential. Light should be direct and not reflected by means of a small

mouth mirror. Small, fine tissue forceps are employed to manipulate the thin oral mucosa without undue trauma. Small scalpels and delicate tissue scissors are necessary to freshen soft tissue margins and extend mucosal flaps. Small, double-ended, spoon curets are helpful to carefully remove root and bone particles and residual infection. A mosquito hemostat should be included for grasping any dislodged root fragment or any obstinately adherent segment of bone.

Silk suture is preferable for closure of the defect. Silk does not absorb moisture as readily as catgut and the knots are more easily tied than those fashioned with any synthetic materials. The synthetic sutures should be soaked before use to increase their pliability, thereby prolonging the procedure.

Small half round or three-eighths round cutting edge needles should be used for coapting the soft tissue. Large gauge needles traumatize soft tissue flaps and impair circulation at the closure site. A small needleholder and suture scissors complete this basic set.

The operator may have certain instruments which he prefers in addition to this set, but the inclusion of sinus curets, rasps and forceps is unnecessary. A diseased antrum cannot be closed from the mouth following its accidental exposure. The presence of active infection in the sinus cavity will break down the thin mucosal flap and leave a large defect which requires skilled treatment for successful results. The treatment of antral disease and a defect in the antral floor requires the attention of an expert in this field and cannot be carried out successfully by dental office procedures.

Closure of the Defect

Intact Antral Mucosa. Closure of a defect in the antral alveolar floor from the oral cavity is less complicated when antral mucosa has not been perforated. The intact mucosa seals off oral infections from the healthy maxillary sinus. If the defect is very small, a blood clot[3] may be maintained in the tooth socket. Pressure should be applied over the saddle area with sterile gauze sponges. This protects the area temporarily if the patient is referred to a specialist for treatment. The use of temporary splints is not advisable in most cases. Modeling compound splints devised to fit over the saddle area must be left in position for several days. Infection of the clot may occur from mouth organisms clinging to the surfaces of the splint. This type of closure is a hit or miss affair and is not the method of choice for definite results. The soft tissue opening over the socket area is closed in all cases involving a healthy maxillary sinus. No closure is successful with a diseased antrum.

Buccal alveolus is trimmed with rongeurs and smoothed to eliminate sharp edges or protruding interdental septa. This reduction of the bulk of buccal alveolus creates excess buccal mucosa in the area. Additional undermining is performed for increased mobility of this flap. This flap of buccal mucosa is moved palatally to bridge the open alveolus by contacting the palatal mucosa. The buccal flap is further stripped from its bony attachment by periosteal dissection. Tension upon this flap may be relieved by an incision at the buccal alveolar fold.[1] A sterile square of Gelfoam, moistened in sterile saline, is placed against the opening in the alveolar floor. This absorbable hemostatic agent reduces bleeding and aids in clot formation. Under no circumstances should a non-absorbable pack be used in antral exposures; oral antral fistulae will inevitably occur and lead to chronic antral infection. Tissue margins are freshly denuded to permit adequate coaptation and suture. Sutures are used to maintain contact of the margins. Additional sutures in this area do not add strength to the closure but usually cause tissue necrosis by interference with circulation of the margins.

Perforated Antral Mucosa. When antral mucosa of the maxillary sinus has been perforated, the antrum is immediately exposed to the mouth bacteria. The patient must be prevented from rinsing the mouth. Rinsing forces fluid into the healthy exposed sinus and out the naris, contaminating these areas on the affected side. Sterile gauze sponges are placed over the tooth socket immediately, and the patient maintains this tampon protection until he visits the experienced surgeon.

SUMMARY AND CONCLUSION

A simple, proven technique for closure of accidental exposure of the maxillary sinus has been outlined. No discussion of complicated palatal flaps is included. Detailed discussion of plastic flaps is reserved for the experienced surgeon. Serious complications may occur following alveolar exposure of the maxillary sinus. The dental operator should be aware of his limitations and perform a service to the patient by referring him to the specialist for treatment.

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Principles of First Aid

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The skillful management of injured persons is apparently of greater importance at present than ever before. This is because the number and gravity of injuries in civilian life has been steadily increasing and it is now widely recognized that the toll, as measured by statistics on mortality, morbidity, and permanent disability, has reached staggering proportions. Also, the threat of an attack on this country with nuclear weapons, with well over half of the population considered to be potential casualties, has apparently not diminished.

It is evident that the majority of the victims of civilian injuries or atomic warfare cannot be treated from the outset by highly trained traumatic surgeons employing the specialized equipment necessary for attaining an optimal survival rate. Conceding that the treatment administered during the first few minutes or hours after injury will be less than ideal, it is obviously necessary to disseminate knowledge concerning traumatic emergencies as widely as possible. It is also important to increase the number of persons who can render treatment approaching the ideal. Those in the dental profession, because of their background and aptitudes, should be able to handle most emergency problems effectively and efficiently. Many readers have no doubt been faced with the general assumption that they can handle the victim of an automobile accident more skillfully than the average lay person with first aid training. The need for members of the dental profession to handle large numbers of casualties independently during nuclear warfare is evident.

It seems important, therefore, to review more than the first aid knowledge generally imparted to lay workers. An attempt will be made

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to discuss briefly the principles of emergency medical treatment as defined by the Federal Civil Defense Administration.

GENERAL CONSIDERATIONS

The objective of the dentist in handling emergency traumatic problems should be to institute the same measures that would be utilized by a skillful traumatic surgeon, rather than to employ stop-gap measures while the patient is rushed to a hospital. By adopting this viewpoint it is possible to avoid the tragic results of "rushing to the hospital," which too often means an increase in the severity of the injury due to improper methods of lifting, lack of immobilization of fractures, etc. If the well established principles of emergency medical treatment are calmly employed, the treatment administered when the patient reaches the hospital will be a continuation of that begun at the earliest possible moment after injury and the patient's chances for survival will not be jeopardized by the adverse effects of ill advised "first aid treatment" superimposed upon his original injury.

The behavior of those responsible for emergency medical treatment is worthy of comment. By remaining calm, speaking in a natural voice and proceeding with confidence and authority, the excitement found at the scene of an accident may often be quickly dispelled. The person who calmly takes charge, surveys the general surroundings, and organizes activities about him in an orderly manner quickly gains the confidence of patients and bystanders. In order to take charge in a calm authoritative manner, it is obviously desirable to have confidence in one's ability to make a satisfactory diagnosis and institute the proper emergency measures.

The first step in any emergency, whether there be one casualty or many, is to survey the situation and make plans which will solve the immediate problems. If only one person is injured, the problem may be relatively simple, at least in regard to tactical planning if not in regard to the injuries which are present. If many individuals are injured, the over-all tactical problems must first be considered and, above all, the individual in charge must undertake the responsibility for *triage*, or sorting. In examining the injured patient and deciding what can be done with the personnel and equipment available, the objective must be the greatest good for the greatest number. Patients who will almost surely succumb no matter how much time and effort is put into treating them—the hopelessly injured—will have to be bypassed in favor of those with moderately severe injuries who have a chance of survival. Likewise, those with relatively minor injuries may have to be assigned to a category in which no treatment can be given

for a considerable period of time during which the maximal effort is devoted to those who require immediate care and who may be expected to benefit therefrom.

EVALUATION OF THE INJURY

A brief history of what has happened, obtained from the patient or from bystanders who can provide reliable information, is an important step which is frequently neglected. Usually only a moment or so will be required to learn what is known about the type of injury, the mechanism and forces producing it, the order of onset of symptoms, etc. There are innumerable examples which might be cited in which no one took the brief history essential for establishment of the correct diagnosis and institution of the proper method of treatment. It is a tragic mistake to omit asking the few questions which are pertinent, because the potential value of a reliable history is so great. The questions which should be asked and the time which should be spent in asking them are matters of experience and judgment. A calm, experienced examiner can often combine history taking with the initial physical examination.

In the initial physical examination, thought must first be given to conditions which may prove fatal without immediate lifesaving treatment. The two most urgent conditions are (1) *hemorrhage* and (2) *respiratory insufficiency*. The question of external hemorrhage can usually be settled by a rapid but thorough inspection of the entire body. The question of respiratory insufficiency can *usually* be settled by brief, close observation of the patient's ability to move adequate amounts of air in and out of his lungs. Obstruction of the upper respiratory tract by the tongue, by blood and mucus, by prolapsing soft tissues, etc. need not be discussed in detail, since dentists have extensive training and experience in diagnosing respiratory insufficiency of this type. Inadequate ventilation due to other causes may be less familiar, and will be discussed below.

The third problem to be evaluated, immediately after the two above, is whether the patient is in *shock*. If he is, the need for treatment may not be so urgent as for hemorrhage or respiratory insufficiency, but resuscitative measures should be employed at the earliest possible moment and it is helpful to start making arrangements for the treatment of shock without delay. When a number of individuals have been injured, over-all planning may be greatly facilitated by assigning shock victims to a separate category and arranging for treatment by a shock team.

While examining the patient for the presence of shock, the general

appearance should also be considered. The state of consciousness, depression of cerebral function, orientation, and all the many other factors relating to traumatic or toxic injury to the central nervous system are important. A common error is to assume that a patient with alcohol on his breath is drunk, rather than semi-comatose as the result of a head injury. Signs which are of value in evaluating the over-all general condition are cyanosis, pallor, restlessness, apathy, temperature and moisture of the skin, and position. Experienced observers may find valuable but subtle clues in the patient's facial expression, i.e., how sick does he look? Palpation of the quality of the pulse may also provide information which is difficult to define but is of considerable value to experienced observers, particularly when combined with the above.

After completing the general examination, it is essential to perform a systematic examination of the entire body, beginning with the head and working downward. The entire skull is palpated for evidence of contusion or fracture, the ears and nose are inspected for evidence of bleeding or leakage of cerebrospinal fluid, the lids, eyeballs and pupils are examined and the upper and lower jaws are scrutinized for evidence of fracture. All other parts of the body are examined in an order which should be learned so thoroughly that there is no danger of omitting any portion, even under stress. Space does not permit discussion of each detail of the examination, which can be found in many publications. Mention should be made of certain points, however. Flexion of the neck, sitting up, or any extreme change in position should be avoided until reasonable efforts have been made to exclude the presence of a fracture of any portion of the spinal column. A complete fracture of the long bones of the extremities can be readily excluded before moving the joints or applying pressure. It is possible to test for injuries of the peripheral nerves and pulses rapidly and efficiently.

EMERGENCY LIFESAVING MEASURES

External Hemorrhage

There are three principal methods of controlling external hemorrhage. These are (1) compression of the bleeding area, (2) compression of the artery proximal to the area which is bleeding, and (3) the use of a tourniquet.

Compression over the Bleeding Area. The use of compression over the area which is bleeding is all that will be required in most instances, even though the bleeding appears to the uninitiated to be much too severe to be controlled by this method. The technique recommended is simply to make a compress larger than the wound, of the cleanest

material available (sterile dressing, handkerchief, shirt, etc.) and apply firm pressure with one or both hands over the wound. A most important adjunct to this simple method of treatment is *elevation of the extremity*. The effectiveness of this simple method can be increased greatly by placing the wound several inches above the trunk, so that the effects of venous pressure are overcome and the effective arterial pressure is reduced. After maintaining steady pressure for five, ten or fifteen minutes, it is often possible to maintain continued pressure by wrapping a bandage around the extremity, thereby freeing the hands of the person applying pressure. The wrapping should not be tight enough to interfere with venous drainage, and elevation should, of course, be continued.

Compression of Artery Proximal to Bleeding Area. Compression of the artery proximal to the site of hemorrhage is applicable only to the neck and extremities, and has distinct limitations. Knowledge of the "pressure points," which formerly was stressed in first aid training, has apparently not been of great practical value. In the neck, the carotid artery may be compressed against the cervical spine, in the upper extremity the brachial artery may be compressed against the humerus, and in the lower extremity the femoral artery may be compressed against the femur (in the upper two-thirds). This may greatly decrease bleeding distally if the pressure is promptly applied. One limitation is that it is difficult to maintain strong enough compression manually for a very long period of time. Another is that complete obliteration of the arterial lumen may not be achieved unless the angle of compression is exactly right. The combination of this method with local compression of the wound and elevation may be effective. Also, proximal compression may be useful for those who know the anatomy of the principal arteries and have a hemostat available, because diminution of the bleeding for a brief period may permit precise application of the hemostat to the artery without injuring veins or nerves.

Application of a Tourniquet. A tourniquet can be used only on the extremities and its use should be much more restricted than was formerly taught in first aid courses. Prompt application of a tourniquet may save a life, however. Our purpose is not to condemn tourniquets but to explain that the indications must be sharply defined because of the potential harm that they cause. The chief danger is loss of the extremity.

To be effective, a tourniquet must be tight enough to stop arterial blood flow. Otherwise, it will merely increase bleeding by obstructing the veins proximally and forcing blood out of the wound. Instability of the tourniquet may result in loosening during transportation, and extensive, unobserved blood loss may result. Also, a major nerve may

be irreparably and unnecessarily traumatized when, for one reason or another, removal of the tourniquet sooner than anticipated becomes possible.

The types of materials to be used and the methods of application are widely known and are subsidiary in importance to the two main principles: (1) use of the tourniquet principally when amputation distally will almost certainly be necessary because of the severity of multiple injuries, and (2) application of pressure somewhat above that of the systolic arterial pressure so that blood loss will be completely stopped and the disastrous results of a venous tourniquet will be avoided. The first principle is altered somewhat by the time factor. If the tourniquet is promptly applied, and can be released within two hours after application to either the upper or lower extremity, the tissues will almost certainly be viable and the use of the tourniquet need not contribute significantly to the decision regarding amputation. Arterial tourniquets are commonly employed for periods up to two hours during elective operations on the extremities.

Release of the tourniquet for five minutes every thirty to sixty minutes, as is apparently still taught by certain first aid instructors, is in our opinion a very questionable practice. If the tourniquet is really necessary, release for a five minute period periodically may result in fatal hemorrhage. Also, the possibility of tourniquet shock cannot be ignored. Circumstances justifying periodic release of the tourniquet can be postulated, however, but certain qualifications must be kept in mind. When the tourniquet is released it may be possible to prevent massive blood loss by applying direct compression over the site of the major bleeding. Also, if it becomes necessary to continue the process for five or six hours or more before a definitive surgical operation can be performed, the danger of precipitating tourniquet shock by releasing the tourniquet increases, and it may be necessary to abandon attempts to save the extremity in the interest of saving the patient's life. Uncertainties about the length of the waiting period prior to operation, contamination of the wound, the patient's general condition, the ambient temperature, and supportive measures available will obviously influence the decision, and these factors make a clear-cut rule unwise. It is a matter of judgment. We believe that consideration of the principles stated above will usually make it possible to pursue a safe course of action.

Respiratory Insufficiency

Removal of Airway Obstruction. Mechanical obstruction to the air passages from the mouth and nose to the trachea should be investi-

gated first when there is inadequate ventilatory exchange, as stated above. Dentists are familiar with this problem but perhaps certain general principles might be stated. The patient should be placed in the prone position with the head turned slightly to the side (provided that injury to the cervical spine has been ruled out) so that blood, secretions and prolapsing soft tissues can be carried downward and outward by gravity. The mouth and pharynx are then explored with the fingers (suitably protected) so that loose fragments of teeth, bone, missiles, etc. can be removed. The tongue is then pulled forward and anchored in that position, if necessary, with a safety pin or any other reasonable traction device, so that the "floor" of the airway will remain depressed, permitting passage of air in and out of the larynx. The patient may be transported in this position, but arrangements must be made to check the patency of the airway repeatedly during transportation.

Tracheotomy. The above measures may not be adequate in patients who have continued swelling of the soft tissues, continued oozing of blood and secretions which cannot be adequately aspirated, injuries to the larynx, vocal cord paralysis, etc. It is well to remember the maxim, "perform a tracheotomy when you first think of it, not as an act of desperation." This principle is important in managing individual patients as well as large numbers of casualties. When the indications are borderline, careful observation is necessary if tracheotomy is to be avoided, and unless careful observation by a person capable of doing a tracheotomy is possible, delay all too often results in a mad scramble subsequently, if not in disaster. For those unfamiliar with the technique of performing an ideal tracheotomy in hurried circumstances, it is undoubtedly much easier and safer to incise the cricoid cartilage than to make the incision at the level of the second to fourth tracheal rings, where the lumen is much deeper and bleeding is apt to be much more brisk.

Treatment of Chest Injuries. If the basic facts concerning cardiorespiratory physiology are understood, the correct diagnosis can nearly always be made by careful inspection, use of the stethoscope, and aspiration of the pleural cavity (thoracentesis).

An open sucking wound due to a penetrating or a perforating missile is readily recognized by hearing the sucking noise and by looking at the wound. An open pneumothorax must be converted immediately to a closed pneumothorax by occluding the wound edges with the cleanest compress type of dressing available. The dressing may be released on expiration during several respiratory cycles to expel a large amount of the intrapleural air. If more air is kept from entering through the wound and there is not an air leak from the surface of the lung, the

mediastinum may then be stabilized and respiratory function is satisfactory. If air continues to leak from a concomitant wound in the lung, a drainage tube the size of an 18 F catheter or larger should be inserted at one end of the chest wound and connected to a water seal drainage bottle, a finger cot or some other suitable mechanism to permit egress of air on expiration but no ingress on inspiration. The patient can be transported safely as long as this protective mechanism is functioning. The wound is débrided in an operating room under positive pressure endotracheal anesthesia, and is closed in an airtight manner around a larger drainage tube, or some type of airtight seal is provided if the wound is not closed.

If the patient is dyspneic and airway obstruction can be excluded (see above), the cause can usually be diagnosed by listening with a stethoscope. The chief causes to be considered are compression of lung tissue by blood or air, and obstruction of a large number of bronchial tubes or even the trachea by blood and secretions. If the lung is compressed, the breath sounds are diminished or absent on that side and the mediastinum is shifted to the opposite side. Enough blood and/or air is removed by thoracentesis to relieve dyspnea. If blood reaccumulates rapidly, again compressing the lung and causing dyspnea, it may be necessary to open the chest to control bleeding. This is not a common problem, however. In general, bleeding inside the chest is either so rapidly fatal that there is not time to undertake an operative procedure, or bleeding occurs at a rate slow enough to permit preparations for operation, during which blood is aspirated in sufficient amounts to relieve dyspnea and is replaced by blood transfusions. The bleeding is usually self-limited, however, if it is not rapidly fatal, and an emergency thoracotomy to control bleeding is not common. Since the pressure in the pulmonary artery is normally only about one-fifth that in the aorta, the accumulation of a moderate amount of blood within the thorax usually stops bleeding from the lung. The principles to be remembered in treating traumatic hemothorax are to aspirate enough blood to relieve dyspnea, if dyspnea is present, and then to wait 48 to 72 hours before removing a portion of the remaining blood each day (500 to 800 cc.) until the lung is fully expanded. If the patient is not dyspneic when first seen, thoracentesis need not be performed for 48 to 72 hours; after this period, gradual aspiration of the blood rarely causes recurrent bleeding.

If recurrent compression of the lung is due to an air leak, there is frequently a valve-like mechanism which permits air to be forced into the pleural cavity with strong expiratory efforts, whereas the air cannot get back into the bronchial tree to be expelled to the outside. Pressure in the pleural cavity may become increasingly high, giving rise to the

condition known as *tension pneumothorax*. The air may gain access to tissue planes of the chest, neck, face and arms where the characteristic crepitus of subcutaneous emphysema is readily palpable. Tension pneumothorax is treated by inserting a catheter into the pleural cavity and connecting it to a water seal drainage bottle or some other one-way valve mechanism, as mentioned above. It is desirable to apply strong suction to the water seal drainage bottle so that the air can be sucked out of the tube more rapidly than it can enter the pleural cavity and the lung may thereby be more rapidly expanded. A tracheotomy may be helpful in certain patients with tension pneumothorax because this prevents the development of high pressures within the bronchial tree and limits the amount of air which can be forced into the pleural cavity and into the tissue planes.

Paradoxical motion is another cause of dyspnea and respiratory insufficiency in patients with chest injuries. If several ribs are fractured in two or more places, the portion of the chest wall between the fractures becomes a "flail," and moves in a direction opposite to that of uninjured portions of the thoracic cage on inspiration and expiration. This interferes seriously with cardiorespiratory function and may be rapidly fatal if a large portion of the chest wall is involved. Stabilization of the paradoxically moving area is the principle to be kept in mind in treatment. The area can be pushed inward and fixed in that position with a strong compression dressing, or some type of skeletal traction may be applied to a rib segment to pull that portion of the chest wall outward, fixing it in that position. A recent development which shows great promise is the use of positive pressure applied to a tracheotomy tube by the insufflation technique with the aid of a respirator, such as that devised by Mörch. Paradoxical motion is a common problem in patients who have crushing injuries of the chest, for example, those injured in automobile accidents.

We would like to stress the fact that it is not necessary to have experience in performing major operations within the chest to treat the vast majority of patients with chest injuries successfully. A sound understanding of cardiorespiratory physiology and a few simple instruments such as a stethoscope, a thoracentesis needle and syringe and rubber catheters will save the lives of most patients with chest injuries. Moreover, patients with chest injuries who can be kept alive long enough to reach a hospital should nearly always recover.

Shock

At the risk of oversimplification, it seems worthwhile to state that shock due to injuries is nearly always the result of loss of whole blood

into the injured area or to the outside. The signs and symptoms of shock are due to reduction in the effective circulating blood volume. The most important principle to keep in mind is that whole blood must be used if traumatic shock is to be overcome and recurrence is to be prevented. Plasma, plasma volume expanders (dextran, gelatin, albumen, etc.) and electrolyte solutions (5 per cent glucose in water or isotonic salt solution) must often be used to augment the circulating plasma volume under emergency conditions, but they must be regarded merely as temporary adjuncts. The term "blood substitute" should be abandoned because there is no substitute for whole blood, and the concept that anything else may take the place of whole blood except as a temporary expedient has caused great harm.

By using universal donor blood (group O, Rh negative) suitably treated or screened to eliminate those with high agglutinin titers, it is not necessary to cross-match the blood prior to administration, and whole blood transfusions can be given at the scene of the accident almost as readily as plasma, the one remaining problem being that of refrigeration.

Severely injured persons who die of what appears to be overwhelming shock in a short period of time can undoubtedly be saved if adequate amounts of whole blood are administered soon after injury. This is the ideal for which we must strive. It is perhaps equally important to recognize that the blood pressure of severely injured persons can be brought to viable levels and maintained for periods up to a few hours by administering plasma volume expanders such as gelatin and dextran. At present it is not possible to store whole blood for more than about three weeks, and this obviously limits advance planning for large scale disasters. It seems likely that storage of whole blood for much longer periods of time will soon be possible.

In shock due to burns, plasma rather than whole blood may be lost into the burned area, especially during the first few hours. The principles stated above need not be greatly altered even in the case of burns, however, because burn victims will have a moderate to severe anemia by the third or fourth day if they do not receive whole blood transfusions as well as plasma.

Other measures which are helpful in treating shock, when not contraindicated, are elevation of the lower extremities or the foot of the bed, maintenance of relatively normal body temperature, relief of pain and anxiety by administration of suitable drugs in relatively small doses, immobilization of fractures, and maintenance of optimal cardiorespiratory function.

Burns

Burns have become increasingly common in civilian life and will be an important problem in a high percentage of the casualities in the event of atomic warfare. It is difficult to tell whether a burn is first, second or third degree soon after it is sustained, and an attempt to

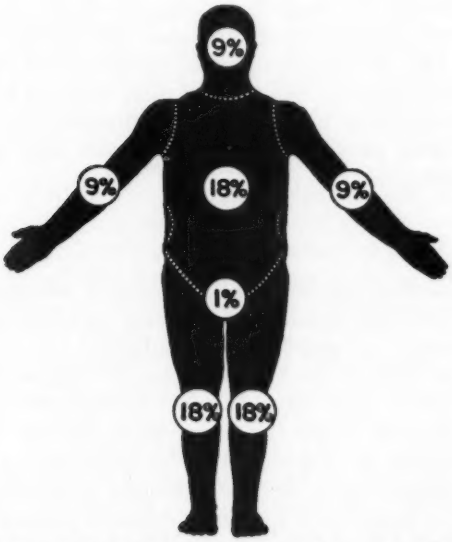

Fig. 1. Estimation of the extent of body surface burn: rule of nines. The body is divided into various segments, each representing 9 per cent or multiples thereof. The head and each arm are given 9 per cent; the anterior trunk, posterior trunk and both lower extremities are given double 9, or 18 per cent; and the genitals are given 1 per cent. (From Artz, C. P. and Soroff, H. S.: J.A.M.A. *159*:411, Oct., 1955.)

estimate the depth of the burn has little practical importance in an emergency. The percentage of the body surface involved is of much greater importance and can be estimated with reasonable accuracy by employing the "rule of nines" (Fig. 1). The mortality rate is low in burns of 15 per cent or less, moderate in burns of 15 to 30 per cent, and high from 30 to 50 per cent. When more than 50 per cent of the body surface is involved, the mortality rate is high even with the best treatment. For those over the age of 60 the prognosis is even more grave in the above categories. The principle of primary importance in

the emergency treatment of burns is administration of whole blood, plasma, plasma volume expanders and glucose in saline solutions—in that order of preference—to combat shock and maintain adequate function of the kidneys, liver and other vital organs. Relatively simple formulas have been devised for calculating the blood, plasma and electrolyte requirements during the first 24 to 72 hours. A presentation of these formulas is not possible here, but perhaps it should be stated that the volume of fluid administered parenterally in a patient with a 30 to 50 per cent burn during the first 48 hours may seem unbelievably large to those unfamiliar with burn therapy. Factors of less importance in treating burn patients are relief of pain with analgesic drugs, local treatment of the burn wounds by either the open or the closed method, maintenance of adequate ventilation if there is a burn of the respiratory tract, avoidance of infection, use of antibiotics, and the administration of tetanus toxoid (or antitoxin, to those who have not been previously immunized).

Wounds

Certain general principles to be observed in managing traumatic wounds may be briefly stated. These remarks apply only to local treatment and not to general problems discussed above.

All traumatic wounds should be considered contaminated, and after a period of 6 to 8 hours, when bacterial multiplication and invasion begin, an early stage of infection is potentially present. An important objective, therefore, is débridement of the wound within 4 to 6 hours after injury whenever possible. The technique of débridement cannot be described in detail but it is perhaps sufficient to state that all portions of the wound should be so thoroughly excised and cleansed that when the procedure is complete the wound looks as if it had been made with a scalpel for an elective operation. Except when a wound can be treated soon after injury under ideal circumstances, without the undue haste and inadequate subsequent observation which almost inevitably accompany the management of a large number of casualities, the wound should be left open after it is débrided. Between the fourth and the tenth day a thin zone of granulation tissue will have appeared, and the skin edges may be closed loosely if the débridement has been adequate. This is termed *delayed primary suture*. The risk of invasive infection is minimized by this method, and the increase in the amount of scar tissue and the duration of wound healing are not great. If the loss of skin has been so great that the skin edges cannot be approximated at the time of delayed primary suture, split thickness skin grafts can be applied at this time.

Fractures

The most important principle in the emergency treatment of fractures is immobilization. In trying to decide whether a fracture is present, either open or closed, it is advisable to rely on such general signs as pain, deformity, loss of function, etc., rather than attempting strenuous manipulations to demonstrate crepitus or false motion. If in doubt, the suspicious area should be adequately immobilized ("splint 'em where they lie").

Fractures of the Spine. Transportation of patients with possible fracture of the spine is worthy of mention because ill advised maneuvers may result in permanent paralysis below the level of the fracture. Patients with fractures of the cervical spine should be transported in the supine position with the neck extended and supported in the midline by sandbags or manually. It is convenient to transport such patients on a board. A wooden door is often readily available. Patients with fractures of the dorsal and lumbar spine should be transported in the prone position, and an increase in the lordotic curve is usually desirable. If a patient with a suspected fracture of the spine has to be turned to the proper position, it may be advisable for several persons to support portions of his head and trunk so that separate motion of individual vertebrae may be avoided.

Fractures of Extremities. Fractures of the shoulder and humerus may nearly always be satisfactorily immobilized for transportation by application of a sling with the elbow at right angles and gentle firm fixation to the trunk. Fractures around the elbow joint are often best left in the position in which they are found. In any event, the position in which they are splinted during transportation should be one in which the radial pulse is palpable. Fractures of the forearm, wrist and hand can usually be temporarily immobilized by splinting with a magazine, newspaper, shingle, etc. The proper use of a Thomas splint during transportation of patients with fractures of the lower extremity is one of the most rewarding measures in emergency treatment. This is true because the muscles of the lower extremities are so strong that any mobility of the fracture site during transportation may greatly increase the amount of blood loss and crushed muscle, not to mention pain. If a Thomas splint is not available, the proper application of a wood splint extending from the axilla downward on the site of the fracture, or careful bandaging together of the two extremities, is often effective.

Open Fractures. The emergency management of open fractures (formerly called compound fractures) is not essentially different except that the protruding portion of the fractured bone should be covered

with a sterile gauze dressing. Also, at least in the case of the lower extremity, more is to be gained by drawing the exposed bone back beneath the soft tissues as strong traction is applied with a Thomas splint than by applying an unstable splint which leaves the bone fragment exposed until it can be properly cleansed. Even greater care must be taken in débriding open fractures than in simple soft tissue wounds if bone infection is to be prevented. The objective in the upper extremity is to obtain mobility, even at the expense of some shortening, whereas strength, stability and preservation of approximately normal length are the objectives in the lower extremity. Bone fragments should not be removed if it seems likely that they retain sufficient periosteal attachment to insure adequate blood supply.

CONCLUSION

We have discussed in this article lifesaving measures that may be necessary soon after an injury has been incurred. However, it is more important to know the main principles upon which proper emergency treatment of injuries is based, and to understand the physiologic mechanisms underlying these principles, than to memorize lists of steps to be taken for specific injuries.

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Legal Aspects of Emergency Treatment

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Approach to this subject must be made in realization of the fact that there is little statutory authority for reference. Nowhere, it is believed, are there divisions in the codes of the states and commonwealths which list or recite many laws relating to emergencies. Nor are there collections of legal maxims pertaining to that field like those found in equity. The situation is comparable to that encountered in the textbooks of geography used in the little red schoolhouses a century ago when studying the interior of Africa. Owing to the limited explorations of that time, the maps pictured dense vegetation, elephants, lions and crocodiles instead of detailed topographic data and survey lines denoting provincial and national boundaries.

Most of the law applicable to emergencies stems from decisions of courts which have employed as standards the yardsticks of general law governing the practice of medicine and dentistry. It is well established that the practitioner is held to the rule of treating his patients with care and skill, and with that quality prevailing in the community. There are also laws dealing with the contractual relationships, consent to operation or treatment, consultation, x-rays, liability for the actions of employees in the scope of their employment, evidence and licensure. Adaptation of these regulations and principles to conditions of urgency has resulted in a substantial reservoir of "bench-made law," and *stare decisis;* that is, upholding precedents and maintaining former adjudications. Thus there is a reasonably well defined pattern for dealing with emergencies, considering, of course, the facts and circumstances of the case at hand.

It must be said that there are certain perils attending the treatment of emergencies, particularly if they are such as to require extraordinary efforts or means. The situation reminds one of the old story of the veteran army sergeant who, when asked by a hopeful raw recruit how

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he might insure the success of a career in the armed services, replied: "Never volunteer, and make five copies of all paper work." While this advice may have doubtful value as a formula for great achievement, it contains more than a modicum of common sense. Although the character of emergencies generally allows little time for weighting all the factors of liability, the dentist should consider his problem in the knowledge that additional legal responsibilities attach to his undertaking. Fortunately, as the author of a textbook on dental jurisprudence observes: "From the very nature of the professional duty, such emergency cases must be of rare occurrence in dentistry."[1]

Laws governing the practice of the healing arts apply alike to the physician and to the dentist. Since the legal literature contains relatively little material dealing with dental cases, this article will refer extensively to the holdings in medical treatment where the general conditions apply to both professions.

THE NATURE OF AN EMERGENCY AND OF THE DENTIST'S RESPONSIBILITY

An appellate court has said that "an emergency is an unforeseen combination of circumstances which calls for immediate action, and that when an emergency occurs there is an immediate necessity to cope with it."[2] One of the most common instances in dental practice is that of an unusual amount of hemorrhage during and/or after the extraction of teeth. Such a situation should never be considered lightly as an accepted incident of extraction. Not only should the dentist render prompt treatment to arrest the profuse bleeding but he should exercise good judgment in assuring himself that it is under control before dismissing the patient. A court case resulted in the finding that the dentist performing the extraction owed a duty to the patient while under his care to see that he remained in the office while there was still danger of hemorrhage, and the further duty, on being informed of the patient's condition, to provide immediately such care and attention as was reasonably necessary to relieve that condition.[3] Severing an artery in the course of extraction creates a serious emergency, yet a dentist negligently omitted to verify the source of extensive post-extraction hemorrhage. Hours later the patient procured the services of another dentist who discovered the severed artery and sutured it, stopping the bleeding. In litigation of the case the decision favored the plaintiff patient in his action against the first operator.

While the dentist is not held to be a guarantor of the results of his services in the absence of a contract by which he binds himself, he is responsible in all professional procedures, routine or emergency, for

the exercise of reasonable skill, care and prudence. In a medical case the court stated that "It is common knowledge that the removal of a portion of the soft palate and of the uvula is no part of a tonsillectomy."[4] It likewise would be no part of the extraction of an impacted maxillary third molar. Nor would the partial enucleation of the parotid gland be a part of the removal of that tooth. Such conditions arising during treatment are definitely emergencies, and, in the event that the assistance of an oral surgeon or a physician is not at once available, require such remedial effort as the dentist can render. The same is true when severe injury and hemorrhage result from the slipping of a revolving bur or disk which has penetrated the floor of the mouth and/or has cut the tongue. The trend to the use of high speed dental engines possibly makes such an occurrence more than ever one to prevent by special care. A tooth, or fragment thereof, lodged in respiratory organs during extraction under general anesthesia, surely creates an emergency demanding the best efforts at correction or palliation until competent assistance may be procured.

The law holds that such events as those recited belong in that category where the *res ipsa loquitur* rule of evidence is applicable. This doctrine—"the thing speaks for itself"—is a weighty handicap for the defendant practitioner to overcome in court by evidence in rebuttal. In some instances it has also been maintained successfully by the prosecution that the dentist should not have undertaken treatment of the case in the first place; that by reason of his lack of experience, skill or equipment for the proper performance of the service indicated he owed a duty to the patient to refer him to a practitioner able to accomplish the work skillfully.[5]

THE QUESTION OF CONSENT

Many of the allegations charging the dentist with malpractice, trespass and assault are predicated on the contention that consent was not given for the services rendered. In this area the law is considerably more liberal in its consideration of the treatment of emergencies than of routine cases. It is legal consensus that ordinarily a dentist must limit his work to that authorized by the patient; that by exceeding such authorization he commits technical assault or trespass. In an emergency, however, it is held generally that there is implied consent to do those things necessary at the time to save the life of the patient or to preserve his health, he being unable to give consent, or to refuse it.[6] This has application also to a child or to a person mentally incompetent. This judicial attitude does not include questionable emergencies, and the practitioner should be sure of the indication for the

immediate need of his services before proceeding with treatment. Patients who are unconscious from injury or sudden illness or are in shock from trauma or exposure, or cases of acute physical disability in those suffering mental handicap, would come well within the rule. So would the intoxicated person needing medical or dental help urgently. The test is whether or not there is a condition of emergency necessitating immediate treatment calculated to preserve life and/or health.

The practitioner, if sued by his thankless patient denying consent, express or implied, cannot rely naively on absolution by the courts without a proper defense. The rules of evidence establish the means by which juries are given the facts upon which to base their findings. He should cooperate fully with his insurers in supplying the facts of the situation, the names of witnesses, and such other information as may be of value in defending the action. In the ordinary malpractice suit the patient must offer expert testimony to prove that the dentist performing the professional service did not meet the accepted standard of practice in the community, and that such failure resulted proximately in the injury alleged in his complaint. It is not necessary that an expert witness be called when the allegation against the defendant dentist is that of operation without consent, or breach of contract to cure. This makes it extremely important that the dentist have presented in his behalf ample material to prevent the plaintiff's establishment by a preponderance of evidence the proof of his allegations.

THE BROKEN NEEDLE

Emergencies involving the breakage of syringe needles while injecting anesthetic solution are not uncommon. As a rule the law regards such occurrences benignly, even when the results may be somewhat serious. This does not mean wholesale condonation; far from it! It does provide assurance that such breakage may be a reasonable risk the patient assumes. Again, the courts do not hold the dentist to be an insurer of his services unless he has been foolish enough to guarantee them by contract. Needles may have hidden defects. Their quality or temper may have been impaired by conditions unknown to the dentist and beyond his control. The patient may have moved his head suddenly. The interest of the court is chiefly that of ascertaining whether or not the dentist used the skill and care exercised by the practitioners of the general locality. That inquiry will include the efforts made by him to deal with the emergency; in fact, that is the most significant part. If it is learned that he employed proper means to remove the fractured needle, or that he procured competent assistance in the case, the courts usually view the situation as an unavoidable happening or

at least one without fault of the operator. This has been true in instances where long lasting or permanent sequelae have been involved: partial paralysis of the tongue, abnormal sensation in the area of the nerve injury, drooling and decreased effectiveness in biting. It is interesting, too, that *res ipsa loquitur* does not apply in such cases; expert testimony is relied upon to establish the adequacy or inadequacy of the treatment provided.

ACCEPTED STANDARDS IN TREATMENT

The treatment of emergencies, like that of ordinary dental procedures, should include no experimentation. Courts may recognize that conditions of great urgency require prompt and bold handling, but they likewise hold that the treatment should be that of accepted standards.[7] If unusual methods or techniques are considered to be indicated they should not be undertaken until after consultation and the patient has signed a paper acknowledging and assuming the risk. Emergencies are often of such degree as to preclude this. And under no circumstances will courts uphold a contract by which the dentist has sought to absolve himself of negligence in treatment. Such agreements are regarded at law as being contrary to the public good.

It should be remembered also that consent, express or implied, in treating emergencies does not authorize unnecessary surgery. The services rendered must be limited to those required by the circumstances. In the event of suit, evidence adduced in court forms the basis of determination as to what treatment reasonably was necessary, and as to whether or not the defendant dentist went beyond his authority in rendering the treatment which is the subject of the complaint.

ACCIDENTS IN THE DENTAL OFFICE

Occasionally office emergencies arise from accident. At law there is no liability in tort for purely accidental injuries. The test is that of determining whether or not the act producing the injury is one which ordinary human care and foresight are unable to guard against. And what constitutes ordinary care varies with circumstances. The falling of x-ray equipment upon a patient, damaging his person, is regarded as having been avoidable. Likewise, a patient's slipping on the highly polished floor of the dentist's reception room when stepping on a small throw rug hardly larger than a doily, with resultant back injury, is considered a preventable accident. These cases should be given immediate emergency treatment, of course, by the dentist to the best of his ability and by a physician procured as promptly as possible.

Fainting, frequently encountered in dental practice and not in itself strictly an accident, may lead to a serious one. A dentist, in the course of removing a fainting patient from the operating chair to a lounge, brushed against a sterilizer containing boiling water, tipping it over and scalding parts of the patient's body. Here the treatment of the emergency became an actionable matter, and in subsequent suit against the dentist the court awarded judgment to the plaintiff patient. The law holds that "Any want of the proper skill or care which diminishes the chance of the patient's recovery, prolongs his illness, increases his suffering, or, in short, makes his condition worse than it would have been if due skill and care had been used, would, in a legal sense, constitute injury."[8] Also, as to the consequences of accident: "The person legally responsible for personal injury to another may be held liable for all the consequences of the cause producing injury or traced to it, and the consequences so arising may go on increasing until, by a final judgment or award, a limit is put to the liability. No defense is available in the fact that an utterly trivial injury has produced results the serious nature of which is out of all proportions to the force which inflicted it, provided that such results are the natural and reasonable consequences of the injury, having regard to all the facts existing at the time. For example, it may be no defense that the ultimate result is due to the aggravation of an old disease in existence before the injury, or that the consequences would have been less serious but for the weak health or condition of the plaintiff."[9]

EMERGENCY TRACHEOTOMY

While this article deals with facts and the holdings of the courts which apply to the practice of the healing arts, featuring the treatment of emergencies, the writer desires to inject these paragraphs of speculation as to the legal view which might obtain regarding an unusual kind of emergency which could arise during dental treatment. On the premise that a small cotton roll, sponge or other foreign body may be inspired into the upper trachea, and lodge there firmly, the patient quickly becomes cyanotic and is in immediate danger of suffocation. No medical assistance is available and there is neither time, nor are there suitable instruments at hand, for attempting to reach and withdraw the obstruction to breathing. Would the dentist, under the circumstances, be justified legally in performing tracheotomy and intubation?

During World War II wide publicity was given a report that a soldier performed such an emergency operation on a suffocating officer, using a pocket knife as the incising instrument and the barrel of a

fountain pen as a tube. This first aid was successful, and the operator was commended, later being offered a tuition-free course in medical college. It is true that medical aid soldiers are taught to use emergency measures to save life and relieve pain in war. It is recognized, also, that policies and regulations employed by the armed forces in combat are not necessarily those of civilian life and peacetime conditions. It is submitted, however, that the dentist in the present instance probably would be upheld at court, irrespective of the result of his effort, and provided that he used care and such skill as he could. Although not a subject of judicial cognizance, it is believed the court would accept the fact that "The danger of foreign bodies in the mouth, throat and larynx is immediate, as death may ensue if they are not at once removed."

Further, though the practice of dentistry is limited in its field to the oral cavity, or to "the teeth and adjacent tissues," the dentist's duties include reduction and fixation of fractures of the maxilla and mandible, administering anesthesia, blocking nerves and treating infections. How far the "adjacency" extends, in this case, reasonably might be held by the court to include the area of emergency operation by association or even under the doctrine of "legal fiction." These observations, it is repeated, are conjectural, and are offered in that vein. Insofar as is known there is no reported case of the kind in the records of court decisions. Until one based essentially on the facts as recited in this submitted hypothesis is passed upon by a court of appellate status, it seems both logical and reasonable to believe that the trial court would apply the existing principles of law relating to medical and dental practice, the facts of extreme urgency and the demand for heroic measures, and the elements of care and skill in the procedure, to the end that the undertaking would be held not only to be justified, but possibly a duty owed the patient.

LIABILITY IN MILITARY SERVICE

Returning to the accepted legal aspects of practice, and since reference was made to the armed forces in the preceding section, it may be well to comment on the responsibilities and liabilities the physician and the dentist assume on entering the military establishments. A physician's liability as regards malpractice is not changed when he is treating military personnel as a medical officer of the armed forces. The Judge Advocate General of the Army has held that members of the Army "are entitled to the same civil rights of action between one another with reference to suits for malpractice or negligence as they would have in civil life."[10] This official pronouncement would apply

as well to dentists under the law that "Ordinary rules governing duties and liabilities of physicians and surgeons are equally applicable to kindred branches of the healing professions,"[11] and should be understood by those entering the uniformed forces of the national defense.

ABANDONMENT OF A CASE

While the dentist by law may accept such patients as he chooses, once the relationship of operator and patient is established, there may be no abandonment of the case without the consent of the patient or proper notice by the dentist so that the services of another practitioner may be obtained. This rule applies particularly to emergencies. The dentist owes the duty of performing service for the patient, securing assistance, and/or referring him to one competent to treat his condition skillfully.[12] If the patient abandons the dentist, denying him the opportunity of rendering the service required, and within his ability and duty to perform, he is held to be guilty of contributory negligence. This action on the part of the patient ordinarily releases the dentist from liability for injury alleged by the plaintiff patient in suit, provided it can be shown that reasonable care and skill characterized the treatment.[13]

ANESTHETIC EMERGENCIES

Dentists are authorized to administer general anesthetics in the performance of their professional services. It follows that they are bound to deal with such emergencies as may arise in that administration, and/or to procure medical assistance with all dispatch. Respiratory failure, cardiac reactions and injuries demand quick and intelligent care. It is presumed that no dentist would employ general anesthesia without such examination or report as would assure him of the patient's condition as to tolerance. Even death under general anesthesia creates no implication of negligence; proof of negligence must be established by competent evidence. The opinion is offered, however, that failure to cope with an emergency when death reasonably might have been prevented would be regarded as such omission or dereliction of duty as to be indefensible.

CIVIL ACTION BY HEIRS

It is worthy of mention at this point that at common law there was no civil action for the wrongful death of another person. Such a right of action has been established in practically all American jurisdictions

by statute. Known as the Wrongful Death Statute, it provides a new cause of action in favor of the heirs, based upon the financial loss suffered by them due to the death of the deceased relative. The general rule in its application requires that there be proof of actual dependency, that there may be only one action, and that such action—in most states—be introduced within one year of the time of death.

LIABILITIES IN RENDERING FIRST AID

Undertaking the treatment of emergencies outside of practice and not within one's general scope of professional activity may be most commendable from the humanitarian point of view, but the modern Good Samaritan must be willing to accept possible legal risks. This does not mean that the law frowns on such righteous endeavor. In fact, it provides that a passer-by, or anyone, may call a hospital or a physician to come to the aid of a person on the street, highway or other general premises, helpless through injury or acute illness, without incurring financial responsibility. To hold otherwise would be to discourage the public from seeking such assistance for fear of inviting costs. And it decrees that any person, whether physician, dentist, nurse or layman, may render first aid if he feels competent to do so. Rescues from drowning or fire, artificial respiration, emergency obstetrical service by laymen, the application of temporary emergency tourniquets to check dangerous hemorrhage, and supplying warmth to persons in shock are but a few of these common situations. The law reminds those, however, who hold themselves out as physicians, whether they are or not, that they are liable for their tortious acts. Some cases which might invoke the disfavor of the law are those wherein distinctly wrong and unsupportable aid was rendered, or too much treatment was given, resulting in more harm than good. Some cases, unfortunately, prove to be those in which the benefactor literally "kills with kindness" the person he is striving to assist. Moving or the undue handling of one suffering an acute cerebral episode may be dangerous for both the keeper and his brother under inexcusable circumstances.

An authority in medical jurisprudence writes: "It has been indicated that first aid may be rendered without establishing the relationship of physician and patient. However, more than one doctor has stopped on the highway to give emergency first aid, not intending to assume any other or further responsibilities and has later been sued by the person whom he endeavored to help. For example, a physician stopped one Sunday afternoon at the scene of an automobile accident and applied protective, temporary immobilization to an injured elbow. The

physician was on his way to the mountains for a vacation. He so told the patient and advised him to go at once to his own physician. The advice was not followed. Deformity and loss of function eventuated. The physician was sued and a large judgment obtained against him, the patient maintaining that the doctor had told him that the dressing should not be disturbed for several days, and that the arm would be all right."[14]

It is such an experience as this that recalls the advice, "Never volunteer," yet the ethics of the practitioner urges his acceptance of the responsibility. It is regrettable that he has so little protection against the unforeseen complications that may arise. Apparently the defense of contributory negligence on the part of the patient did not prevail, and one who undertook an act of mercy paid dearly for his efforts. One shudders to speculate on the outcome if the first aid had been administered by a passing dentist. It may be that he would have been saved by the legal holding that "If a practitioner frankly informs a patient of his want of skill, or the patient is in some other way fully aware of it, the latter cannot complain of the lack of that which he knew did not exist."[15]

A famous old case resulted in a happier ending for the defendant. It is recited because of the pronouncements of law it contained, rulings which have long been accepted. It involved a midwife employed to deliver the mother of the plaintiff. After delivery it was found that the plaintiff baby had an inflammatory condition of the eyes. The defendant midwife said she could cure this, that she had been successful in treating many similar cases, and insisted that there was no occasion to call a physician. She proceeded with treatment, using simple washes. The case actually was one of purulent ophthalmia, and so far failed in response to the applications of rosewater that the child became totally blind. The plaintiff's attorneys argued that the defendant undertook treatment of the eyes, creating a legal duty of the defendant toward the plaintiff, whether the defendant was a regular physician or not, and even though the eye treatment was gratuitous, there was a duty to use reasonable care and skill. As to the plaintiff's mother's competency as a witness it was contended that she had employed the defendant as a midwife twice before; that the duties to be performed were known to her; and the contract, implied, must have been entered into with reference to them. The court, in holding for the defendant, stated: "A physician must apply the skill and learning which belong to his profession; but a person who, without special qualifications, volunteers to attend the sick, can at most be only required to exercise the skill and diligence usually bestowed by persons of like qualifications under the circumstances. To hold otherwise

would be to charge responsibility in damages upon all who make mistakes in the performance of kindly offices for the sick."[16]

CONCLUSION

All persons are presumed to know the law; whether they really do or not is immaterial as its effects are applicable to all. It is recognized that the treatment of emergencies carries with it the assumption of some risks, but there is reasonable and heartening assurance of legal support if the situation is one of real urgency where immediate action to save life or health is imperative. The end justifies rational means, and following the safe course of observing the community's standards of care and skill will usually prevail. Dentistry, like medicine, is not an exact science; the practitioners of both professions are charged, ethically and legally, with employing their knowledge, judgment and skill in all treatment they render, routine and emergency. And dentistry, like medicine, has made vast progress since the beginning of the present century. On the other hand, the state statutes relating to licensing for the practice of dentistry remain much the same as they were decades ago. It is the decisions of the courts, founded on the statutory law but taking into consideration the problems created by the advances in dental training, practice and scope, that establish generally the rights and responsibilities of both the dentist and his patient today. This being true, and since there are greatly more dentists, more patients, more problems and more emergencies than at the time the laws were enacted, it is reasonable to speculate that more up to date statutes may be expected from time to time. In the meantime increasing effort should be directed to that area in which both the law and society agree fully: the truly best way to treat emergencies is to prevent them.

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Emergency Equipment in the Dental Operating Room

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"It can never happen in my office!"

We all like to believe this, but unfortunately, accidents do happen in dental operating rooms. True, the percentage is gratifyingly small, but every one of us must be prepared to cope with an emergency. To be properly prepared, we must have on hand the necessary equipment and we must know how to use it.

In this discussion there will be mentioned a number of items which should be immediately available in every dental office, and there will be included brief statements of their application. More detailed instructions for dealing with specific emergencies will be found in other articles in this symposium.

HEMORRHAGE

Not long ago a very capable dentist called me on the telephone to say that he had just had an accident in his office. A disk had slipped and buried itself in the floor of a patient's mouth. She was hemorrhaging badly, he needed assistance, and he brought her to my office. Actually, the dentist was quite capable of taking care of the emergency, but he did not have in his office the proper equipment.

Excessive hemorrhage in a dental office may be primary or secondary to dental extractions. Primary hemorrhage of a severe nature may follow accidental laceration from instruments.

Excessive bleeding from a tooth socket can be controlled by packing the socket with ¼ inch iodoform gauze saturated with a hemostatic agent such as racemic ephedrine. Occasionally, a suture tightly placed across the lips of the socket will be sufficient to control bleeding.

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In major hemorrhage resulting from the severing of a blood vessel in the oral cavity, it is necessary to identify the bleeding vessel immediately and control the bleeding by application of a hemostat. (The use of pressure on the bleeding point is only a temporary measure in serious hemorrhage, and it is not practical in some areas in the oral cavity.) The bleeding vessel can then be secured with a plain 00 catgut ligature, and the wound can be closed with silk sutures.

In order to be properly prepared for such an emergency the dentist should always have ready a sterile emergency tray, kept in one place that is known to all of the office personnel. This tray should contain three or four hemostats, a scalpel, scissors, threaded suture needles, dressing forceps, and a spool of ligature, as a minimal requirement. Articles used should be replaced immediately after the emergency has terminated.

Remember the signs of the different types of hemorrhage:
Spurting, bright red blood—arterial bleeding.
Steady flow of dark red blood—venous bleeding.
Slow, persistent ooze—capillary bleeding.

ANESTHETIC EMERGENCIES

Every dental operating room should be equipped with portable oxygen apparatus (an oxygen tank, a carriage, and a face mask). Oxygen has priority over all emergency drugs in dealing with anesthetic emergencies.

In addition to a source of oxygen, there should be always available a sterile emergency tray equipped to handle anesthetic emergencies. This tray should contain the following items:

Luer syringe, 2 or 3 cc.
Needles for intravenous and intramuscular injections
Aromatic spirits of ammonia, ampule and liquid
Coramine, 1 or 5 cc. ampules
Sterile camphor in oil (1 cc. administered intramuscularly)
Epinephrine (Adrenalin) hydrochloride, 1:1000 in 1 cc. sterile ampules
Caffeine sodium benzoate (7½ grains administered intramuscularly)
Brandy (½ to 1 ounce administered orally)
Ether (1 or 2 cc. ampules, administered hypodermically)
Metrazol (1, 2, or 3 cc. ampules, administered hypodermically)

Also, in any dental office in which either local or general anesthesia is used, a suitable recovery room is a prerequisite to the proper control of anesthetized patients.

Certainly it is true that the best way to treat emergencies is to prevent them. Since the proper choice of anesthetic and the proper care of anesthesia equipment is necessary to prevent accidents in anesthesia, a few words about these matters are in order.

General Anesthesia

The administration of a general anesthetic in the dental office should never be undertaken by one who is acting in the dual capacity of surgeon and anesthetist. Such action will mean poor anesthesia and sloppy surgery. General anesthesia, to be safely administered and to provide a smooth and satisfactory plane of anesthesia for the surgery to be properly executed, requires a trained anesthetist. When there are no contraindications to its use, local anesthesia is the modality of choice in the one-man office.

The most common emergency involving a patient under general anesthesia is respiratory embarrassment. This may be corrected by elevating the mandible forward to relieve obstruction by the tongue occluding the pharynx, and by clearing the airway of mucus and blood or a throat pack that may be obstructing normal respiration. When the airway is open, oxygen can be administered. If respiration fails, insertion of a finger into the rectum and dilation of the anal sphincter will often suffice to reestablish breathing. In the male patient, squeezing the testicles has been found useful in causing him to take a deep breath. In all such cases, controlled respiration by oxygen inhalation must be continued until the patient resumes normal breathing.

When explosive gases are used, added precautions must be taken. Open flames must be extinguished, and no equipment capable of generating a spark (e.g., the high frequency cautery) can be employed. Steps must also be taken to avoid conditions which might give rise to a static electric spark; for example, nurses should not wear nylon uniforms.

Local Anesthesia

Carpules have largely supplanted other forms of storage for local anesthetic solutions. These carpules should be kept in a sterile solution, and the glass container should be plainly marked with the name of the agent and the dosage of each carpule. It is of great importance that this procedure be followed in order to prevent injection of the wrong solution.

The various syringes and needles used in local anesthesia should also be sterilized and kept available in sterile containers. Sterilization of

needles for hypodermic use is best accomplished by autoclaving rather than by cold-solution sterilization. Although flaming a hypodermic needle will render it sterile, it also tends to make the needle brittle and thus increases the chance of needle breakage during an injection.

If a needle should break and be deeply buried, no attempt should be made to remove it until its location has been established by roentgenography. The dentist who has been unfortunate enough to have this accident occur should resist the temptation to explore for the needle unless he is quite familiar with the anatomy of the region involved and has had experience in the removal of foreign bodies. An inexperienced operator's repeated attempts to remove a broken needle will only complicate the case by traumatizing the tissue and destroying the anatomic landmarks. When such an accident occurs, the case should be referred to a person who is experienced in the removal of deep-lying foreign bodies.

Syncope is a common complication of local anesthesia. It is due largely to rapid fall in blood pressure, and it can be treated by placing the patient in a supine position and administering oxygen. Two major causes of syncope are emotional reactions and too-rapid injection of the anesthetic agent. The first can be combated by reassuring the nervous and apprehensive patient and, in cases of extreme apprehension, by administration of short-acting sedatives prior to injection. The second cause can be eliminated by observing at all times the rule that injections should be administered slowly.

Because the pharyngeal reflex is often lost when the anterior palatine nerve has been anesthetized at the posterior palatine foramen, there is in this situation an increased chance that a loose article within the oral cavity will drop back into the throat and be aspirated, causing respiratory embarrassment. If the cause of the obstruction (for example, a tooth, a filling, a gauze pad) cannot be recovered by a suitable instrument and cannot be expelled by the action of the pharyngeal reflexes, an airway must be provided within minutes. Insertion into the trachea of a No. 14 needle equipped with a special adaptor for an oxygen tube will provide adequate aeration until a bronchoscopist can assume management of the case.

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